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AUTHOR	Westbrook, Raymond E.
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ABSTRACT

Developed in Georgia, this manual contains 101 projects for use in machine shop courses, arranged according to a suggested machine shop curriculum. Each project, included in a student workbook, contains complete drawings and instructions for implementation. Tasks are listed under the broad headings of measuring, layout, bench work, saws, drilling, lathe, shaper, milling machine, and grinding. The guide contains a chart of project/task relationships and project listings both by a broad spectrum of tasks and by specific tasks. References are included, along with instructions on use of the manual. (KC)

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MACHINE SHOP PROJECTS

Developed Under a Grant from

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1980

to:
Augusta Area Vocational-Technical School

Author:
Raymond E. Westbrook
Instructor, Machine Shop

Drawings:
George W. Baggs, Jr.
Instructor, Drafting and Design

CE 027 733

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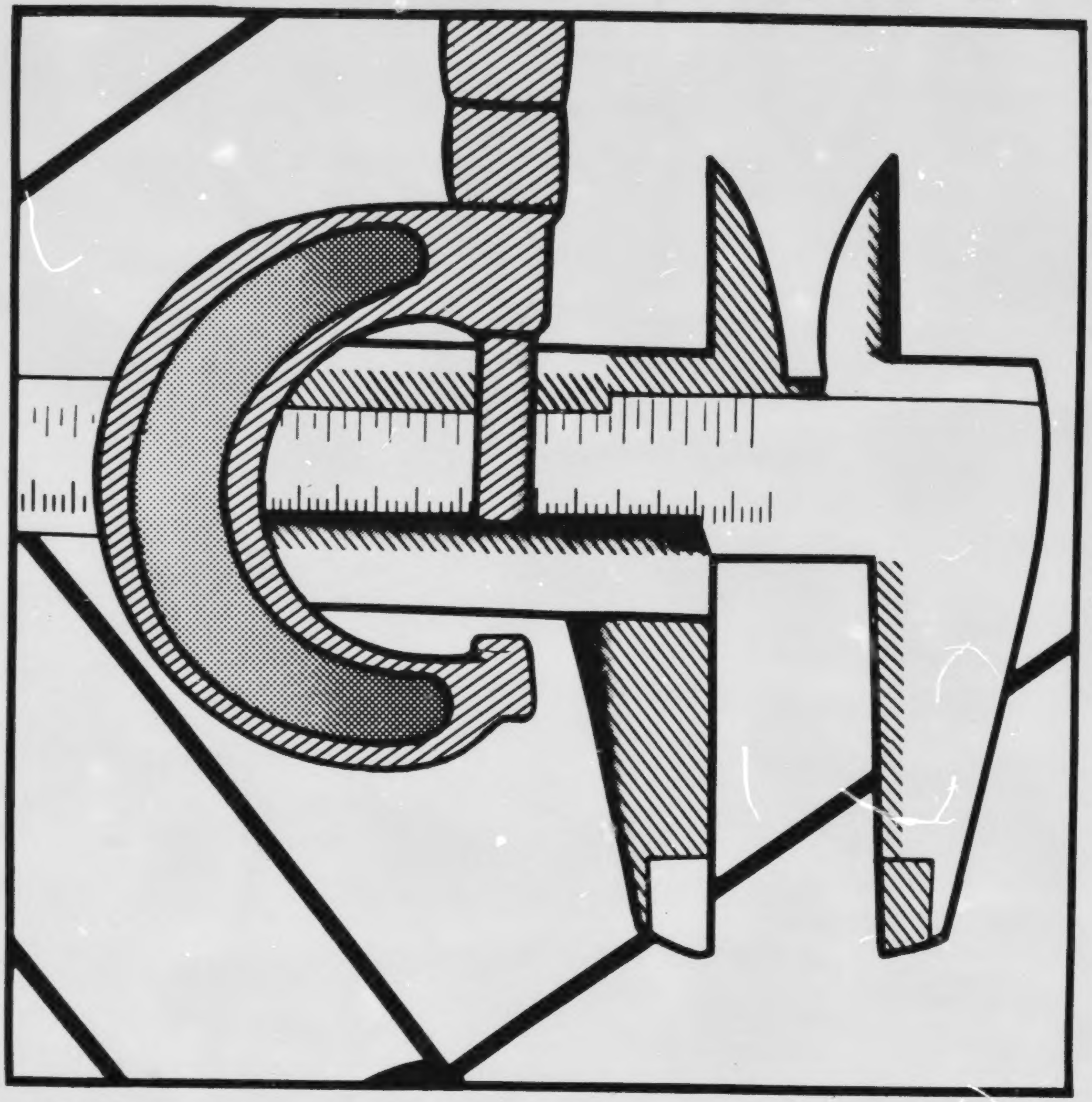
MACHINE SHOP PROJECTS



INSTRUCTOR GUIDE
GENERAL INFORMATION

Georgia Department of Education

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INTRODUCTION

This manual has been developed to take a student through an orderly step by step sequence of learning. Each of the many machine tools have been analyzed and arranged from simple to complex courses. Each course is then further refined into step sequences and tasks. Every task must be performed to obtain maximum learning benefits from each course. These tasks are satisfied by useful projects found in the Machine Shop Project Guide. Not only will these projects satisfy each task, but they will also satisfy the students desire to succeed. Most of the projects produce tools that can be used in the Machine Shop lab, providing better training on a limited budget as well as providing a substantial savings to the taxpayer.

USE OF THE MANUAL

Machine Shop labs and local demands are different throughout the state. The instructor should preview the task list and project/task relationship chart to select the projects that satisfy their area and lab needs. If necessary, further alterations of materials, project design and machining methods may be made.

The Project List (Broad), (a numerical listing of projects) serves as a guide for selecting projects by degree of difficulty. By referring to this list and the Machine Shop Project Catalog, you will be better able to select projects for students at any level of proficiency. Certain tasks in one course may serve as prerequisites for tasks in a preceding course. Therefore, as projects are selected, numerical sequence must be adhered to, in certain instances, so that continuity of training will not be compromised. An asterisk * appearing next to a project denotes a combination project which combines several skills or tasks into the finished product. A student would finish part of this project in one course and come back to this same project again and again in progressive courses until all parts have been completed and/or assembled.

The Project List (Specific) identifies the projects which will satisfy each course in the suggested Machine Shop course curriculum.

The reference list, compiled of books and manuals, is for use by both the instructor and the student. They refer to the reference list for specific information on these courses, projects and tasks. It includes certain books used in the design of certain projects as well as various general Machine Shop texts and handbooks.

In selecting projects to be designed, first, determine what is to be taught or what tasks you would like to combine. Example: Measuring with a steel rule. First, locate this in the task listing under measuring. The task number is M - 1. Next refer to the project/task relationship chart for measuring. Each project number with "x" in the block under M - 1 will satisfy the task of measuring with a steel rule. A more detailed look at each of these particular projects, in the Machine Shop Project Guide, will enable you to select the one or more projects which will best suit your student needs and lab situation.

SUGGESTED MACHINE SHOP CURRICULUM STRUCTURE

I. MEASURING
   A. Semi-Precision
   B. Measuring by Contact
   C. Precision Measuring

II. LAYOUT

III. BENCH WORK

IV. SAWS
   A. Power Hacksaws
   B. Horizontal Band Saws
   C. Vertical Band Saws

V. DRILLING

VI. LATHE

VII. SHAPER

VIII. MILLING MACHINES
   A. Horizontal
   B. Vertical

IX. GRINDING
   A. Bench
   B. Surface
   C. Tool and Cutter

TASK LISTING

MEASURING

SEMI-PRECISION

TASK:

M - 1 Measuring with short length rule and holder

M - 2 Measuring a shoulder or step

M - 3 Measuring with a steel rule

M - 4 Using a rule as a straight edge

M - 5 Measuring using a hook rule

M - 6 Measuring with the block and rule method

M - 7 Measuring with a steel tape

M - 8 Measuring with a rule depth gage

M - 9 Measuring with a slide caliper rule

MEASURING BY CONTACT

TASK:

M - 15 Measuring with an outside caliper

M - 16 Measuring with an inside caliper

M - 17 Measuring with an inside caliper using a micrometer

M - 18 Measuring with a radius and fillet gage

M - 19 Using a thread pitch gage

M - 20 Using a center gage

M - 21 Using an acme thread gage

PRECISION MEASURING

TASK:

M - 30	Measuring with an outside micrometer caliper
M - 31	Measuring with an inside micrometer caliper
M - 32	Measuring with an inside micrometer
M - 33	Measuring with a micrometer depth page
M - 34	Measuring with a vernier caliper
M - 35	Measuring with a vernier height gage
M - 36	Measuring with a small hole gage
M - 37	Measuring with a telescoping gage
M - 38	Measuring with a thread micrometer
M - 39	Measuring with a vernier bevel protractor
M - 40	Measuring with a sine bar
M - 41	Using a dial indicator
M - 42	Using a surface plate

LAYOUT

TASK:

L/0 - 1	Using layout tables
L/0 - 2	Using a scriber
L/0 - 3	Using a combination set
L/0 - 4	Using a surface gage
L/0 - 5	Using layout blue
L/0 - 6	Using a divider
L/0 - 8	Using a prick punch
L/0 - 9	Using a center punch
L/0 - 10	Using an automatic center punch
L/0 - 11	Using parallels
L/0 - 12	Using solid keyseat rule
L/0 - 13	Using a vernier height gage
L/0 - 14	Using hermaphrodite calipers

BENCH WORK

TASK:

B - 1	Using a bench vise
B - 2	Using a bell-peen hammer
B - 3	Using allen wrenches
B - 4	Using a screwdriver
B - 5	Using a hand hacksaw
B - 6	Using a file
B - 7	Using a tap
B - 8	Using a die
B - 9	Using a hand reamer
B - 10	Using an arbor press
B - 11	Using a broach
B - 12	Using a letter and/or number punch set
B - 13	Using an electric hand drill
B - 14	Using a chisel

SAWS

HORIZONTAL

TASK:

S - 1 Cutting to length on a horizontal band or power hacksaw

S - 2 Cutting an angle on a horizontal band saw

VERTICAL

S - 3 Cutting an angle on a vertical band saw

S - 4 Cutting an internal surface on the vertical band saw

S - 5 Cutting a circle on a vertical band saw

S - 6 Cutting a radius on a vertical band saw

DRILLING

TASK:

D - 1	Drilling on a drill press
D - 2	Reaming on a drill press
D - 3	Boring on a drill press
D - 4	Countersinking on a drill press
D - 5	Counterboring on a drill press
D - 6	Spot facing on a drill press
D - 7	Tapping on a drill press
D - 8	Center drilling on a drill press
D - 9	Using a rotary table on a drill press

LATHE

TASK:

L - 1	Grinding a general purpose lathe tool
L - 2	Grinding a roughing lathe tool
L - 3	Grinding a turning tool
L - 4	Grinding a facing tool
L - 5	Grinding a necking tool
L - 6	Chucking in a three-jaw chuck
L - 7	Chucking in a four-jaw chuck
L - 8	Facing in a lathe
L - 9	Turning in a lathe
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
L - 13	Working between centers
L - 14	Turning a shoulder on a lathe
L - 15	Knurling on a lathe
L - 16	Cutting off in a lathe
L - 17	Filing in a lathe
L - 18	Polishing in a lathe
L - 19	Grinding in a lathe
L - 20	Honing in a lathe
L - 21	Grinding a threading tool
L - 22	Cutting external V-threads in a lathe
L - 23	Cutting internal threads in a lathe
L - 24	Tapping in a lathe
L - 25	Cutting an acme thread

L - 26	Using a micrometer stop
L - 27	Using a mandrel
L - 28	Cutting a taper with the compound rest
L - 29	Cutting a taper with the taper attachment
L - 30	Cutting a taper by off-setting the tailstock
L - 31	Boring in a lathe
L - 32	Using a face plate
L - 33	Using a steady rest on a lathe
L - 34	Using a follow rest on a lathe
L - 35	Necking in a lathe
L - 36	Cutting a radius in a lathe
L - 37	Chucking in a collet chuck
L - 38	Cutting a cam in a lathe

SHAPER

TASK:

SP - 1 Trueing a vise in a shaper

SP - 2 Shaping a horizontal surface

SP - 3 Shaping an angle using a vise

SP - 4 Shaping an angle using the head

SP - 5 Grinding a shaper tool

SP - 6 Shaping a vertical surface

SP - 7 Shaping a slot

SP - 8 Form cutting on the shaper

MILLING MACHINES

TASK:

ML - 1	Aligning a vise on a milling machine
ML - 2	Slot milling on a vertical milling machine
ML - 3	Slot milling on a horizontal milling machine
ML - 4	Plain milling/slab milling
ML - 5	End milling
ML - 6	Fly cutter/shell end mill (Face milling)
ML - 7	Angle milling on a vertical milling machine
ML - 8	Angle milling on a horizontal milling machine
ML - 9	Keyseat milling on a vertical milling machine
ML - 10	Keyseat milling on a horizontal milling machine
ML - 11	Form milling
ML - 12	Straddle milling
ML - 13	Slitting and parting
ML - 14	Indexing on a milling machine
ML - 15	Gear cutting on a milling machine
ML - 16	Helical milling on a milling machine
ML - 17	Using a rotary table on milling machine

GRINDING

TASK:

G - 1 Dressing the wheel for grinding

G - 2 Off-hand grinding

G - 3 Grinding an angle on a tool and cutter grinder

G - 4 Grinding a flat on a surface grinder

G - 5 Grinding an angle on a surface grinder

G - 6 Grinding a vertical surface on a surface grinder

G - 7 Form grinding on a surface grinder

G - 8 Aligning work to be ground

G - 9 Grinding a roughing cut

G - 10 Grinding a finishing cut

G - 11 Grinding a universal angle vise

G - 12 Center the wheel head

G - 13 Grinding on a magnetic chuck

G - 14 Grinding cylindrical work on a tool and cutter grinder

G - 15 Using a cut-off wheel

Project / Task Relationship Chart

COURSE MEASURING **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	M - 1	M - 2	M - 3	M - 4	M - 5	M - 6	M - 7	M - 8	M - 9			M - 15	M - 16	M - 17	M - 18	M - 19	M - 20	M - 21			M - 30	M - 31	M - 32	M - 33	M - 34	M - 35	M - 36	M - 37	M - 38	M - 39	M - 40	M - 41	M - 42							
1	X																																							
2	X														X																									
3	X								X																															
4						X						X																												
5					X																																			
6	X											X																												
7	X																																							
8	X			X					X																															
9					X		X		X																															
10	X			X	X							X																												
11	X			X					X			X	X																											
12				X					X												X																			
13									X						X						X																			
14	X																								X															
15																																								
16							X						X																											
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18	X			X										X							X				X															
19															X						X																			
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31		X						X													X					X														
32		X																			X																			
33																					X																			
34																					X																			

Project / Task Relationship Chart

COURSE MEASURING **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	M - 1	M - 2	M - 3	M - 4	M - 5	M - 6	M - 7	M - 8	M - 9			M - 15	M - 16	M - 17	M - 18	M - 19	M - 20	M - 21			M - 30	M - 31	M - 32	M - 33	M - 34	M - 35	M - 36	M - 37	M - 38	M - 39	M - 40	M - 41	M - 42							
35																					X																			
36		X																			X																			
37		X																			X																			
38		X																			X																			
39						X		X				X			X						X																			
40																																								
41															X																	X								
42														X														X												
43		X	X																																					
44																						X						X		X										
45																															X		X							
46									X																							X								
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49	X																								X															
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65																	X									X			X											
66																																X								
67																					X			X								X								
68																																								

Project / Task Relationship Chart

COURSE MEASURING **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	M - 1	M - 2	M - 3	M - 4	M - 5	M - 6	M - 7	M - 8	M - 9	M - 15	M - 16	M - 17	M - 18	M - 19	M - 20	M - 21	M - 30	M - 31	M - 32	M - 33	M - 34	M - 35	M - 36	M - 37	M - 38	M - 39	M - 40	M - 41	M - 42
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70																													
71																													
72												X										X						X	X
73						X							X																
74			X							X						X										X		X	
75																X		X		X								X	
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97																			X	X									
98																												X	
99																													
100																													
101																	X											X	

Project / Task Relationship Chart

COURSE	LAYOUT	**TASK NUMBER**	**MACHINE SHOP**

PROJECT NUMBER	L/O - 1	L/O - 2	L/O - 3	L/O - 4	L/O - 5	L/O - 6	L/O - 7	L/O - 8	L/O - 9	L/O - 10	L/O - 11	L/O - 12	L/O - 13	L/O - 14
1	X	X	X		X			X						
2	X	X	X		X	X		X	X					
3		X												
4		X												
5	X		X		X				X					X
6														
7	X	X						X	X		X			
8	X	X	X		X	X		X		X				
9	X	X	X		X				X					
10		X	X		X			X	X					
11		X				X		X	X					
12		X	X		X	X		X	X	X				
13		X	X		X			X						
14		X			X				X					
15		X	X											
16			X					X				X		
17	X	X	X		X	X								
18		X			X									
19			X											
20			X											
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23			X											
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25			X											
26			X											
27			X											
28			X											
29			X											
30			X											
31	X												X	
32		X	X		X									
33														
34														

Project / Task Relationship Chart

COURSE LAYOUT **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	L/O - 1	L/O - 2	L/O - 3	L/O - 4	L/O - 5	L/O - 6	L/O - 7	L/O - 8	L/O - 9	L/O - 10	L/O - 11	L/O - 12	L/O - 13	L/O - 14
35														
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43	X			X	X									
44	X			X	X									X
45			X	X							X			
46	X				X								X	
47		X	X		X					X				
48														
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Project / Task Relationship Chart

COURSE LAYOUT

TASK NUMBER **MACHINE SHOP**

PROJECT NUMBER	L/O - 1	L/O - 2	L/O - 3	L/O - 4	L/O - 5	L/O - 6	L/O - 7	L/O - 8	L/O - 9	L/O - 10	L/O - 11	L/O - 12	L/O - 13	L/O - 14
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98						X			X		X			
99														
100														
101														

Project / Task Relationship Chart

COURSE BENCH WORK **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	B - 1	B - 2	B - 3	B - 4	B - 5	B - 6	B - 7	B - 8	B - 9	B - 10	B - 11	B - 12	B - 13	B - 14
1					X	X								
2	X	X			X	X						X	X	
3	X	X			X	X		X						
4		X			X	X								X
5	X						X							
6	X				X	X		X						
7		X			X	X								
8		X			X	X							X	
9						X		X						
10	X				X	X	X							
11							X							X
12	X	X				X		X						
13						X			X	X				
14			X		X	X								
15			X	X										
16	X	X												
17						X		X					X	
18						X								
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29														
30														
31														
32					X	X		X						
33														
34														

Project / Task Relationship Chart

COURSE BENCH WORK **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	B - 1	B - 2	B - 3	B - 4	B - 5	B - 6	B - 7	B - 8	B - 9	B - 10	B - 11	B - 12	B - 13	B - 14
35														
36														
37														
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20

Project / Task Relationship Chart

	COURSE	BENCH WORK	TASK NUMBER	MACHINE SHOP

PROJECT NUMBER	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14
69														
70														
71														
72										X	X			
73					X	X			X	X				
74														
75						X			X	X				
76														
77				X										
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96														
97														
98						X				X	X			
99														
100														
101														

Project / Task Relationship Chart

	COURSE	SAWS		**TASK NUMBER**	**MACHINE SHOP**	
PROJECT NUMBER	S – 1	S – 2	S – 3	S – 4	S – 5	S – 6
1						
2						
3						
4						
5	X					
6						
7						
8						X
9	X					
10	X					
11	X				X	
12	X					
13			X			X
14	X					
15			X			
16	X	X	X			
17	X		X	X		X
18	X					
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26						
27						
28						
29						
30						
31	X					
32	X					
33						
34						

Project / Task Relationship Chart

COURSE	SAWS	TASK NUMBER	MACHINE SHOP

PROJECT NUMBER	S-1	S-2	S-3	S-4	S-5	S-6																																	
35																																							
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50	X	X																																					
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Project / Task Relationship Chart

COURSE SAWS **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	S-1	S-2	S-3	S-4	S-5	S-6
69						
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78						
79						
80				X		
81	X					
82						
83						
84						
85						
86						
87						
88						
89	X	X				
90						
91						
92						
93						
94						
95						
96						
97						
98	X					X
99						
100						
101						

Project / Task Relationship Chart

	COURSE	DRILL PRESSES	TASK NUMBER	MACHINE SHOP

PROJECT NUMBER	D - 1	D - 2	D - 3	D - 4	D - 5	D - 6	D - 7	D - 8	D - 9
1									
2									
3									
4	X	X						X	
5	X								
6									
7	X							X	
8									
9	X						X		
10	X						X		
11	X						X	X	
12	X						X		
13									
14	X	X							
15	X			X	X	X	X	X	
16	X								
17	X						X		
18	X		X					X	
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
31									
32	X			X			X		
33									
34									

Project / Task Relationship Chart

COURSE	DRILL PRESSES	TASK NUMBER	MACHINE SHOP

PROJECT NUMBER	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9
35									
36									
37									
38									
39									
40									
41	X								
42	X						X		
43									
44									
45									
46									
47	X	X		X			X		
48	X						X		
49	X				X		X		
50									
51									
52	X						X		
53									
54									
55									
56									
57									
58									
59	X								
60	X						X		
61	X						X		
62									
63	X								X
64									
65	X								
66									
67									
68	X						X		

Project / Task Relationship Chart

COURSE DRILL PRESSES **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	D-1	D-2	D-3	D-4	D-5	D-6	D-7	D-8	D-9
69	X						X		
70	X						X		
71	X						X		
72									
73	X	X				X		X	
74									
75	X		X					X	
76									
77									
78									
79									
80									
81	X				X			X	
82	X	X	X						
83									
84									
85									
86									
87									
88	X						X		
89	X						X	X	
90									
91									
92									
93									
94									
95	X						X		
96	X	X	X				X	X	X
97									
98	X	X					X		
99									
100									
101									

Project / Task Relationship Chart

COURSE LATHE **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	L - 1	L - 2	L - 3	L - 4	L - 5	L - 6	L - 7	L - 8	L - 9	L - 10	L - 11	L - 12	L - 13	L - 14	L - 15	L - 16	L - 17	L - 18	L - 19	L - 20	L - 21	L - 22	L - 23	L - 24	L - 25	L - 26	L - 27	L - 28	L - 29	L - 30	L - 31	L - 32	L - 33	L - 34	L - 35	L - 36	L - 37	L - 38		
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11						X		X	X												X	X							X											
12	X			X		X		X	X	X	X			X		X																								
13	X			X		X		X		X	X	X	X			X	X										X													
14						X	X	X		X	X	X												X				X												
15																																								
16						X		X																									X							
17						X		X		X	X				X									X				X												
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19	X																																							
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31		X	X	X		X		X		X				X																										
32						X		X						X														X												
33						X		X						X	X			X	X																					
34						X		X						X	X			X	X																					

Project / Task Relationship Chart

COURSE LATHE **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	L-1	L-2	L-3	L-4	L-5	L-6	L-7	L-8	L-9	L-10	L-11	L-12	L-13	L-14	L-15	L-16	L-17	L-18	L-19	L-20	L-21	L-22	L-23	L-24	L-25	L-26	L-27	L-28	L-29	L-30	L-31	L-32	L-33	L-34	L-35	L-36	L-37	L-38		
35						X		X						X	X		X	X	X																					
36						X		X						X	X			X	X									X												
37						X		X						X	X			X	X									X												
38						X		X		X				X	X			X	X									X												
39								X			X				X		X							X				X												
40						X		X	X	X								X	X									X	X											
41			X		X	X	X		X	X	X				X			X										X							X	X				
42						X		X		X	X	X			X																X		X							
43			X			X		X	X	X			X	X	X			X											X											
44						X		X		X	X																	X			X									
45							X	X																				X												
46		X				X		X	X	X	X													X				X												
47						X	X	X	X	X	X	X																X												
48						X		X		X	X	X																					X							
49						X		X	X	X					X							X						X	X							X				
50						X		X	X	X				X																										
51						X		X	X	X						X		X		X																X	X			
52			X			X	X	X	X	X	X	X	X	X		X		X										X		X										
53					X		X	X	X	X	X				X	X													X		X									
54						X		X		X											X	X																		
55						X		X		X												X																		
56						X		X		X												X																		
57							X			X												X																		
58							X			X												X																		
59							X	X		X	X	X		X			X																							
60						X	X	X		X	X																													
61						X		X		X	X		X																					X						
62						X		X	X	X			X	X																X										
63	X			X		X		X	X	X	X				X	X															X									
64						X		X		X				X								X													X					
65					X	X		X		X	X			X							X	X	X												X					
66							X	X		X	X												X																	
67						X		X	X	X	X																				X									
68					X	X		X	X	X	X	X	X	X										X				X	X						X					

Project / Task Relationship Chart

COURSE LATHE **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	L-1	L-2	L-3	L-4	L-5	L-6	L-7	L-8	L-9	L-10	L-11	L-12	L-13	L-14	L-15	L-16	L-17	L-18	L-19	L-20	L-21	L-22	L-23	L-24	L-25	L-26	L-27	L-28	L-29	L-30	L-31	L-32	L-33	L-34	L-35	L-36	L-37	L-38
69					X	X		X	X	X	X	X	X	X										X				X	X						X			
70					X	X		X	X	X	X	X	X	X										X				X	X						X			
71					X	X		X	X	X	X	X	X	X										X				X	X						X			
72						X	X	X		X	X	X		X		X								X		X												
73						X		X	X				X	X	X													X		X				X	X	X		
74																																						
75		X			X	X	X	X	X	X	X	X		X	X						X		X		X			X			X	X	X		X			
76						X		X		X	X			X										X														
77							X	X		X	X			X	X	X								X														X
78						X	X	X	X	X	X	X	X	X							X	X	X			X	X										X	
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92						X		X	X	X				X								X																
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96								X		X					X							X									X	X					X	
97						X		X		X																X					X							
98						X	X	X	X	X	X	X		X	X		X					X											X		X			
99						X		X	X	X				X																								
100																																						
101						X		X		X										X																		

Project / Task Relationship Chart

COURSE SHAPER **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	SP – 1	SP – 2	SP – 3	SP – 4	SP – 5	SP – 6	SP – 7	SP – 8																																
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Project / Task Relationship Chart

	COURSE	SHAPER	TASK NUMBER	MACHINE SHOP

PROJECT NUMBER	SP - 1	SP - 2	SP - 3	SP - 4	SP - 5	SP - 6	SP - 7	SP - 8
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64	X	X						
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Project / Task Relationship Chart

	COURSE	SHAPER	**TASK NUMBER**	**MACHINE SHOP**

PROJECT NUMBER	SP - 1	SP - 2	SP - 3	SP - 4	SP - 5	SP - 6	SP - 7	SP - 8
69								
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76								
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78								
79	X	X	X	X	X			
80	X	X	X	X	X	X	X	
81	X	X	X					
82	X	X			X	X	X	
83	X	X			X	X		X
84	X	X	X		X			X
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Project / Task Relationship Chart

COURSE MILLING

TASK NUMBER **MACHINE SHOP**

PROJECT NUMBER	ML - 1	ML - 2	ML - 3	ML - 4	ML - 5	ML - 6	ML - 7	ML - 8	ML - 9	ML - 10	ML - 11	ML - 12	ML - 13	ML - 14	ML - 15	ML - 16	ML - 17																							
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Project / Task Relationship Chart

	COURSE	MILLING	TASK NUMBER	MACHINE SHOP

PROJECT NUMBER	ML - 1	ML - 2	ML - 3	ML - 4	ML - 5	ML - 6	ML - 7	ML - 8	ML - 9	ML - 10	ML - 11	ML - 12	ML - 13	ML - 14	ML - 15	ML - 16	ML - 17
35																	
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44																	
45																	
46		X															
47		X			X			X									
48																	
49																	
50	X	X		X	X	X	X										
51																	
52					X									X			
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Project / Task Relationship Chart

COURSE MILLING **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER		ML - 1	ML - 2	ML - 3	ML - 4	ML - 5	ML - 6	ML - 7	ML - 8	ML - 9	ML - 10	ML - 11	ML - 12	ML - 13	ML - 14	ML - 15	ML - 16	ML - 17
69			X											X				
70			X											X				
71			X											X				
72									X									
73																		
74																		
75	X	X	X		X			X					X					
76	X			X										X				
77					X									X				
78				X		X				X				X				
79																		
80	X	X			X													
81																		
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83	X	X			X		X											
84																		
85	X			X				X										
86	X				X		X											
87	X		X		X	X					X							
88			X										X	X				
89		X			X	X	X							X				
90		X			X		X										X	
91	X	X			X	X	X											
92												X		X				
93	X		X	X									X					
94	X				X	X	X											
95												X	X					
96					X												X	
97											X			X	X			
98	X			X	X			X		X	X			X	X			
99				X	X							X		X		X		
100	X			X	X						X							
101																		

Project / Task Relationship Chart

COURSE	GRINDING	**TASK NUMBER**	**MACHINE SHOP**

PROJECT NUMBER	G - 1	G - 2	G - 3	G - 4	G - 5	G - 6	G - 7	G - 8	G - 9	G - 10	G - 11	G - 12	G - 13	G - 14	G - 15
1															
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18															
19	X	X													
20	X	X													
21	X	X													
22	X	X													
23	X	X													
24	X	X													
25	X	X													
26	X	X													
27	X	X													
28	X	X													
29	X	X													
30	X	X													
31															
32															
33															
34															

Project / Task Relationship Chart

COURSE	GRINDING	**TASK NUMBER** — **MACHINE SHOP**

PROJECT NUMBER	G - 1	G - 2	G - 3	G - 4	G - 5	G - 6	G - 7	G - 8	G - 9	G - 10	G - 11	G - 12	G - 13	G - 14	G - 15
69															
70															
71															
72															
73															
74	X	X	X					X	X	X	X	X			
75				X									X		
76															
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80															
81															
82															
83	X			X	X		X			X			X		X
84															
85	X			X	X								X		
86															
87															
88															
89															
90															
91	X			X	X	X	X	X		X	X		X		
92															
93	X			X		X	X						X		X
94															
95															
96															
97															
98															
99															
100	X			X			X		X	X			X		
101	X		X					X	X	X		X		X	

38

Project / Task Relationship Chart

COURSE GRINDING **TASK NUMBER** **MACHINE SHOP**

PROJECT NUMBER	G - 1	G - 2	G - 3	G - 4	G - 5	G - 6	G - 7	G - 8	G - 9	G - 10	G - 11	G - 12	G - 13	G - 14	G - 15
35															
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48															
49	X	X													
50															
51	X	X	X												
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PROJECT LISTING (BROAD)

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet I
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand
10. Tap wrench

*11. Pipe flange assembly

*12. C-clamp

*13. Block and tackle

*14. Steel beam trammels

15. Display projects

*16. Jack stand

*17. Gear puller

18. Tool post base
19. Right hand tool (general purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)

27. Right hand tool (facing)

28. V-threading tool

29. V-threading tool (off-set)

30. Acme threading tool

31. Micrometer test block

32. Flaring tool

33. ¼" pin punch

34. 3/16" pin punch

35. 1/8" pin punch

36. Center punch

37. Prick punch

38. Nail set

39. Scriber

40. Dead center

41. Plumb bob

42. Dumbell set

43. Taper plug gage

44. Rocker dish

45. Rocker

46. Tool post body

47. Circle cutter

48. Saw Jig (Fly cutter)

*49. Tap wrench II

*50. Fly cutter

51. Tooth pick holder

*52. Pipe center

53. Taper ring gage

54. Set up bolt ½" x 4"
55. Set up bolt ½" x 6"
56. Set up bolt ½" x 8"
57. Set up bolt 3/8" x 4"
58. Set up bolt 3/8" x 6"
59. Drill reducer
60. Tap drill extension (1/4" - 20 NC tap drill)
61. Tap drill extension (5/16" - 18 NC tap drill)
62. Boring bar holder body jig
63. Boring bar holder body
*64. Boring bar holder base
65. Boring bar holder Inner body
66. Boring bar holder base jig
67. Precision measuring tool block
*68. Milling arbor #40 - 3/8"
*69. Milling arbor #40 - ½"
*70. Milling arbor #40 - 5/8"
*71. Milling arbor #40 - 3/4"
*72. Lathe arbor
73. Mallet II
74. Acme thread/boring tool
*75. Screw jack/indexing steady rest
76. Lathe chuck wrench
77. Internal pipe wrench
78. Buffer/grinder shaft
79. Splitting wedge
80. Flat strap clamp
*81. Parallel clamp

82. 1-2-3 Blocks I
*83. V-blocks
84. Two inch step blocks
85. Beveled straight edge
86. Solid key seat
87. Water valve wrench
88. Paper hone
*89. Boring bar set
90. U-clamp
91. Goose neck clamp
92. Three inch T-slot bolt
93. 1-2-3 Blocks II
94. Three inch step block
95. T-slot nut
*96. Die stock
97. Geared ash tray
*98. Wrench
99. ¼" pitch, 1" lead, left hand, square thread bolt
100. Parallels
101. Grinder test bar

* COMBINATION PROJECTS

PROJECT LISTING (SPECIFIC)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench

*11. Pipe flange assembly

*12. C-clamp

*13. Block and tackle

*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects

*16. Jack Stand

*17. Gear puller

18. Tool post base

MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (general purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. ¼" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
40. Dead center
41. Plumb bob

42. Dumbell set

43. Taper plug gage

44. Rocker dish

45. Rocker

46. Tool post body

47. Circle cutter

48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II

*50. Fly cutter

51. Tooth pick holder

*52. Pipe center

53. Taper ring gage

54. Set up bolt ½" x 4"

55. Set up bolt ½" x 6"

56. Set up bolt ½" x 8"

57. Set up bolt 3/8" x 4"

58. Set up bolt 3/8" x 6"

59. Drill reducer

60. Tap drill extension (¼" - 20 NC tap drill)

61. Tap drill extension (5/16" - 18 NC tap drill)

62. Boring bar holder body jig

63. Boring bar holder body

*64. Boring bar holder base

65. Boring bar holder inner body

66. Boring bar holder base jig

67. Precision measuring tool block

*68. Milling arbor #40 - 3/8"

*69. Milling arbor #40 - 1/5"

*70. Milling arbor #40 - 5/8"

*71. Milling arbor #40 - 3/4"

*72. Lathe arbor

73. Mallet

74. Acme thread/boring tool

*75. Screw jack/indexing steady rest

76. Lathe chuck wrench

77. Internal pipe wrench

78. Buffer/grinder shaft

SHAPER

79. Splitting wedge

80. Flat strap clamp

*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks I

*83. V-blocks

84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge

86. Solid key seat

87. Water valve wrench

88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. ¼" pitch, 1" lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

REFERENCES

1. Krar, S. F. and Oswald, J. W.: Grinding Technology. Albany: Delmar Publishers, 1974

2. Lascoe, Nelson, Porter: Machine Shop - Operations and Setups. Chicago: American Technical Society, 1973

3. Oberg, Erik and Jones, F. D.: Machinery's Handbook. New York, N.Y.: Industrial Press Inc., 1976

4. Morse: Machinist's Practical Guide. New Bedford, Mass: Morse Cutting Tools Division, 1978

5. Krar, S. F.; Oswald, J. W. and St. Amond, J. E.: Technology of Machine Tools. New York: McGraw-Hill Book Company, Gregg Division, 1977

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Title VI - Peyton Williams Jr., Associate Superintendent
of State Schools and Special Services
Title IX - Evelyn Rowe and Myra Tolbert, Coordinators
Section 504 - Jane Lee, Coordinator of Special Education

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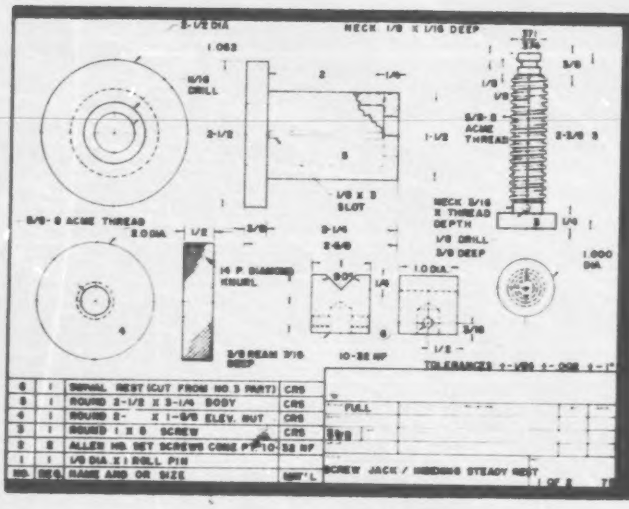
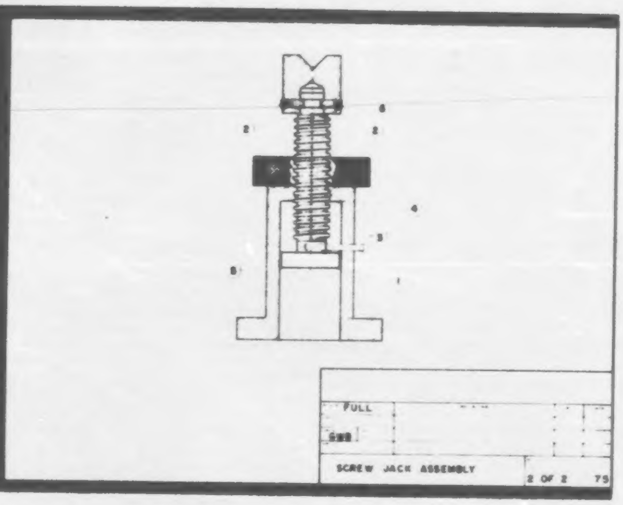
MACHINE SHOP PROJECTS

MEASURING, LAYOUT, BENCH WORK

Projects 1-9


2-1/2 DIA
NECK 1/8 X 1/16 DEEP
1.063
5/16 DRILL
2-1/2
1/8 X 3 SLOT
5/8-8 ACME THREAD
1-1/2
2-3/8
NECK 5/16 X THREAD DEPTH
1/8 DRILL
3/8 DEEP
1.000 DIA
5/8-8 ACME THREAD
2.0 DIA
14 P. DIAMOND KNURL
3/8 REAM 7/16 DEEP
10-32 NF
1.0 DIA.
TOLERANCES
6 1 SWIVEL REST (CUT FROM NO 3 PART) CRS
5 1 ROUND 2-1/2 X 3-1/4 BODY CRS
4 1 ROUND 2- X 1-5/8 ELEV. NUT CRS
3 1 ROUND 1 X 5 SCREW CRS
2 2 ALLEN HD. SET SCREWS CONE PT. 10-32 NF
1 1 1/8 DIA. X 1 ROLL PIN
NO. REQ. NAME AND OR SIZE MAT'L
FULL
SCREW JACK / BENDING STEADY REST
1 OF 2


FULL
SCREW JACK ASSEMBLY
2 OF 2
75

STUDENT MANUAL

Georgia Department of Education

87

MACHINE SHOP PROJECTS

Developed Under a Grant from

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1980

This project was developed under a grant from:

Division of Program Development
Office of Vocational Education
Georgia Department of Education

Project Numbers: 98251 and 28252

to:

Augusta Area Vocational-Technical School

Author:
Raymond E. Westbrook
Instructor, Machine Shop

Drawings:
George W. Baggs, Jr.
Instructor, Drafting and Design

TABLE OF CONTENTS

TITLE

Part A: PURPOSE

Part B: PROJECT LISTING (Categorized)

Part C: PROJECTS - 1-101:

- Cover Sheet
- Information Sheet
- Project Drawings
- Fabrication Procedures

Part D: REFERENCES

PURPOSE

A student in Machine Shop must learn by doing. Although lectures, reading assignments, and audio-visual aids are very necessary, these methods alone will never produce a good machinist. The combination of both classroom and shop practice is essential to your training. The purpose of this Shop Project Guide is to give the necessary shop experience to complement your classroom training. This guide is based on the author's years of practical experience as a skilled machinist and as a teacher in the field. Each skill needed to complete a phase of your training has been identified. Next, projects have been devised to give hands-on experience for each skill with enough repetition so that you will become capable of using each tool or attachment for the particular machine or operation being taught. Your instructor will help you select or will assign the projects in the necessary order. You will also find the end products of these projects will be useful tools that will help in your training that follows. This serves not only to make the projects more interesting, but more enjoyable to construct. This practical training along with classroom instruction and applied learning can bring you a rewarding future as a skilled tradesman.

PROJECT LISTING (CATEGORIZED)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench
*11. Pipe flange assembly
*12. C-clamp
*13. Block and tackle
*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects
*16. Jack Stand
*17. Gear puller
18. Tool post base

MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (genreal purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. 1/4" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
40. Dead center
41. Plumb bob

42. Dumbbell set

43. Taper plug gage

44. Rocker dish

45. Rocker

46. Tool post body

47. Circle cutter

48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II

*50. Fly cutter

51. Tooth pick holder

*52. Pipe center

53. Taper ring gage

54. Set up bolt 1/2" x 4"

55. Set up bolt 1/2" x 6"

56. Set up bolt 1/2" x 8"

57. Set up bolt 3/8" x 4"

58. Set up bolt 3/8" x 6"

59. Drill reducer

60. Tap drill extension (1/4" - 20 NC tap drill)

61. Tap drill extension (5/16" - 18 NC tap drill)

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65. Boring bar holder inner body

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*69. Milling arbor #40 - 1/5"

*70. Milling arbor #40 - 5/8"

*71. Milling arbor #40 - 3/4"

*72. Lathe arbor

73. Mallet

74. Acme thread/boring tool

*75. Screw jack/indexing steady rest

76. Lathe chuck wrench

77. Internal pipe wrench

78. Buffer/grinder shaft

SHAPER

79. Splitting wedge

80. Flat strap clamp

*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks I

*83. V-blocks

84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge

86. Solid key seat

87. Water valve wrench

88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. 1/4" pitch, 1' lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

96

MACHINE SHOP

PROJECT #1

CENTER GAGE

CENTER GAGE

PROJECT #1

COURSES: Measuring, Layout, Bench Work

MATERIALS: Sheet Metal 16 gage - 5/8" x 2" long

TASK:

L/0 - 1	Use of layout table
L/0 - 5	Use of layout blue
L/0 - 3	Use a combination set
M - 1	Measuring with a steel rule
L/0 - 2	Use a scriber
L/0 - 8	Use a prick punch
B - 5	Use a hand hacksaw
B - 6	Use a file

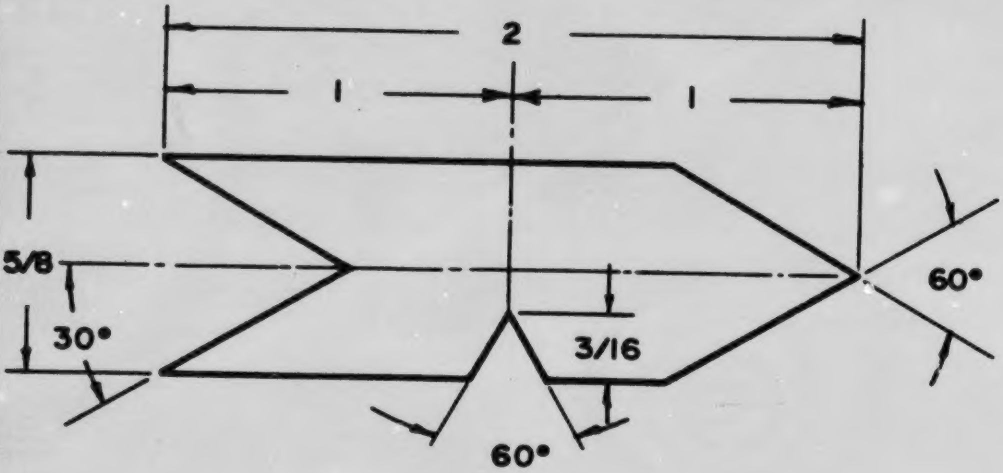
CENTER GAGE

PROJECT #1

PROCEDURES:

1. Coat metal with layout blue
2. Layout all angles
   a. Use a protractor head steel scale and scriber
3. Measure and scribe all lengths and widths
4. Prick punch all scribe lines
5. Cut all scribed lines
   a. Use a hand hacksaw
   b. Leave enough metal for filing
6. File all surfaces to the layout lines
7. True all internal angles and corners
   a. Use a 3 corner file
8. Draw file all sharp edges
9. Check all dimensions before it is turned in for grading

99


2
1
1
5/8
30°
3/16
60°
60°

MATERIAL: 5/8 X 2 X 16 GAGE SHEET METAL
TOLERANCES: ±1/32 · ±1° · ⊥ ±1/32

SCALE 2XSIZE		REVISIONS	BY	DATE
DATE				
DR'N GWB	CKD.			
AP'VD.				
TITLE CENTER GAGE 100			NO. 1	

MACHINE SHOP

PROJECT #2

DRILL POINT GAGE

101

DRILL POINT GAGE

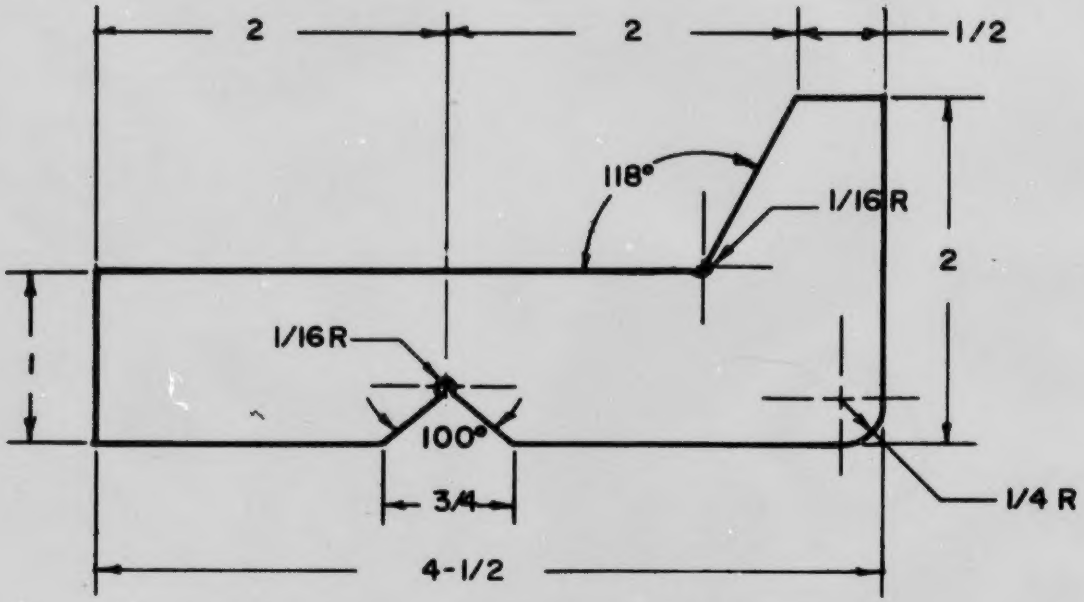
PROJECT #2

COURSES: Measuring, Layout, Bench Work

MATERIALS: One piece cold rolled steel - 1/8" x 2" x 5" long

TASK:

L/0 - 1	Use a layout table
M - 1	Measure with a steel rule
L/0 - 5	Use a layout blue
L/0 - 2	Use a scriber
L/0 - 3	Use a combination set (a+b+c square head and scale protractor)
B - 1	Use a bench vice
B - 6	Use a file
L/0 - 6	Use a divider
L/0 - 8	Use a prick punch
L/0 - 9	Use a center punch
B - 13	Use an electric hand drill
B - 5	Use a hand hacksaw
M - 18	Use a radius and fillet gage
B - 2	Use a ball-peen hammer
B - 12	Use a letter and/or number set


2
2
1/2
118°
1/16 R
2
1
1/16 R
100°
3/4
1/4 R
4-1/2

MATERIAL: 1/8 X 2 X 5 COLD ROLLED FLAT
NOTE: UNLESS OTHERWISE SPECIFIED ALL CORNERS 1/8 R

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD.			
AP'VD.			

TITLE DRILL POINT GAGE

NO. 104 2

103

TOLERANCES: ±1/32 ±1°

DRILL POINT GAGE

PROJECT #2

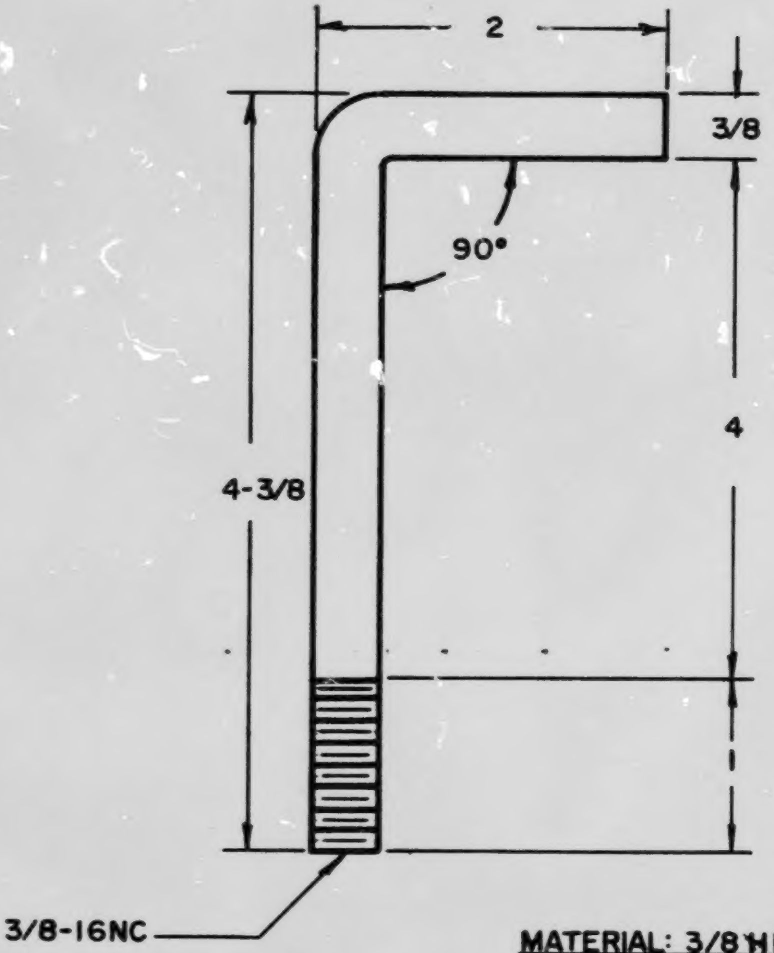
PROCEDURES:

1. Coat stock with layout blue
2. Layout a line squaring one end
3. File to the layout line
    a. Take all dimensions from this end
4. Layout the large radius location
5. Layout lines to be cut
6. Layout angles
7. Prick punch mark all lines approximately 1/2" apart
8. Prick punch mark the center of the large radius
9. Center punch the hole locations
10. Drill the holes
11. Hand hacksaw all the cut lines
12. File to tolerance
13. Check all radii with a radius and fillet gage
14. Mark the angles with number set

MACHINE SHOP

PROJECT #3

ANCHOR BOLT


2
3/8
90°
4
4-3/8
3/8-16NC

MATERIAL: 3/8"HRS- 7" LONG

SCALE	REVISIONE	BY	DATE
DATE			
DR'N GWB · CKD.			
AP'VD.			

TITLE	NO.
ANCHOR BOLT	103 3

107

TOLERANCES: DIMENSIONAL: ± 1/32, ANGULAR: ± 1°

ANCHOR BOLT

PROJECT #3

PROCEDURES:

1. Measure the diameter of the stock
2. Measure the length of the stock
3. File one end square
4. Scribe a line 4" from the end
5. Bend the stock in the vice using a hammer
6. Saw the short side and file to length
7. Round all corners with a file
8. Thread using a die
9. Check all dimensions

MACHINE SHOP

PROJECT #4

MALLET

110

MALLET

PROJECT #4

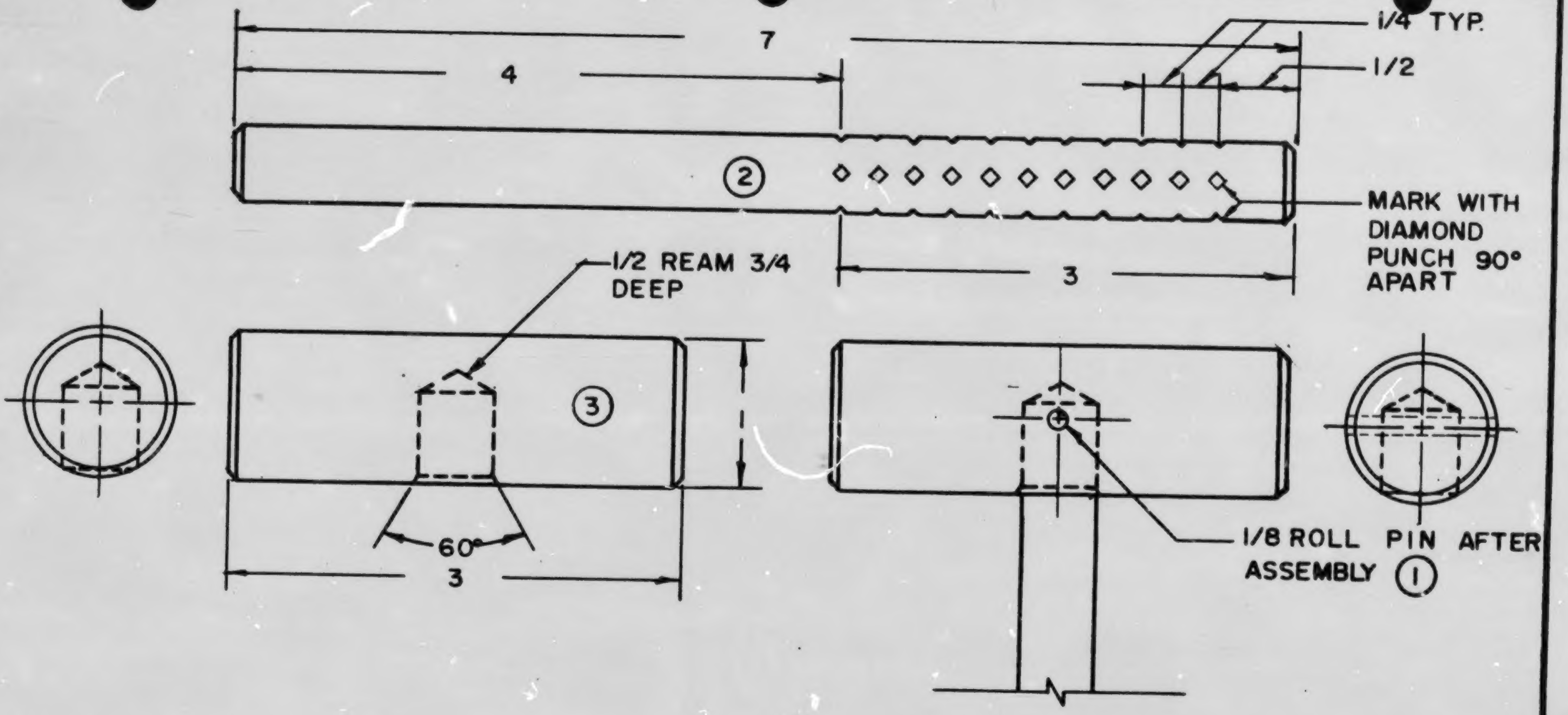
COURSES: Measuring, Bench Work, Layout, Drill Press

MATERIALS: One each, Brass Free Machining - 1" Diameter x 3" Long

One each, Cold Rolled Steel - 1/2" Diameter x 7 1/2" Long

TASK:

M - 15	Measure with an outside caliper
B - 6	Use a file
M - 6	Measure with a block and scale
L/O - 2	Use a scriber
B - 5	Use a hand hacksaw
B - 2	Use a ball-peen hammer
B - 14	Use a chisel
D - 8	Center drill on a drill press
D - 1	Drill on a drill press
D - 2	Ream on a drill press


7
4
1/4 TYP.
1/2
②
MARK WITH DIAMOND PUNCH 90° APART
1/2 REAM 3/4 DEEP
3
③
60°
3
1/8 ROLL PIN AFTER ASSEMBLY ①

NOTE: 1/16 X 45° CHAMFER ALL EDGES

NO	REQ.	NAME AND OR SIZE	MAT.
3	1	1 DIA. X 3 BRASS FREE MACHINING	
2	1	1/2 DIA. X 7	CRS
1	1	1/8 X 1-1/16	CRS

SCALE		REVISIONS	BY	DATE
DATE				
DR'N GWB	CKD.			
AP'VD.				

TITLE
MALLET I

NO.
113 4

MALLET

PROJECT #4

PROCEDURES:

1. Check the size of the steel rod with an outside caliper
2. File one end of the 1/2" stock square
3. Layout the length
    a. Butt the scale and stock against a block
    b. Scribe the length
4. Use a hand hacksaw cut to length
5. File to exact length and round all corners
6. Layout the notches in the handle
7. Use a diamond point chisel and cut the notches
8. Cut and file brass to length
9. Layout holes to be drilled
10. Mount the brass in a vice on the drill press table
11. Center drill to 9/16 diameter for the reamed hole
12. Drill for the reamed hole
13. Ream the hole
14. Assemble the handle into the head
15. Mount the head of the mallet in V-blocks
16. Use parallels and shims and a square head to level the handle
17. Drill for the roll pin
18. Secure the handle to the head with the roll pin
19. Round all corners and remove all sharp edges

MACHINE SHOP

PROJECT #5

STUD BLOCK

STUD BLOCK

PROJECT #5

COURSES: Measuring, Layout, Bench Work, Power Saws, Drill Press

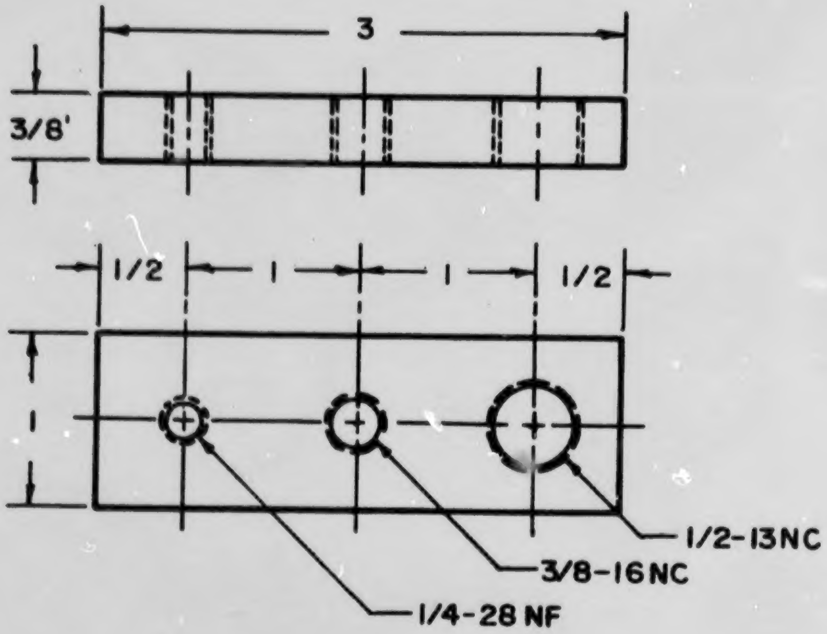
MATERIAL: Cold Rolled Steel - 1" x 3/8" x 3 1/2" Long

TASK:

L/O - 1	Use a layout table
M - 5	Measuring using a hook rule
L/O - 3	Use a combination set
S - 1	Cut to length on a power hacksaw
L/O - 5	Use layout blue
L/O - 14	Use hermaphodite calipers
L/O - 9	Use center punch
D - 1	Drill on the drill press
B - 1	Use a bench vice
B - 7	Use a tap

116

21


3
3/8'
1/2
1
1
1/2
1
1/2-13NC
3/8-16NC
1/4-28 NF

MATERIAL: 1 X 3/8 X 3 COLD ROLLED STEEL

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB · CKD.			
AP'VD.			

TITLE STUD BLOCK

NO. 118

5

117

TOLERANCES: DIMENSIONAL ±1/32 ⊥ ±1/32

STUD BLOCK

PROJECT #5

PROCEDURES:

1. Check the size of the stock using a hook rule
2. Cut the stock to length with a power hacksaw
   a. Allow enough stock to file square and to length
3. File both ends square and to length
4. Coat with layout blue
5. Use hermaphrodite calipers to scribe a center line
6. Layout the hole locations
7. Center punch the hole locations
8. Set up the drill press for drilling
   a. Use a vice and parallels
9. Drill the holes to the proper tap drill size
   a. Refer to tap drill chart in the machinery handbook
10. Place the stock in a bench vice
11. Tap the holes to the proper thread series
12. File all edges

119

MACHINE SHOP

PROJECT #6

STUDS

120

STUDS

PROJECT #6

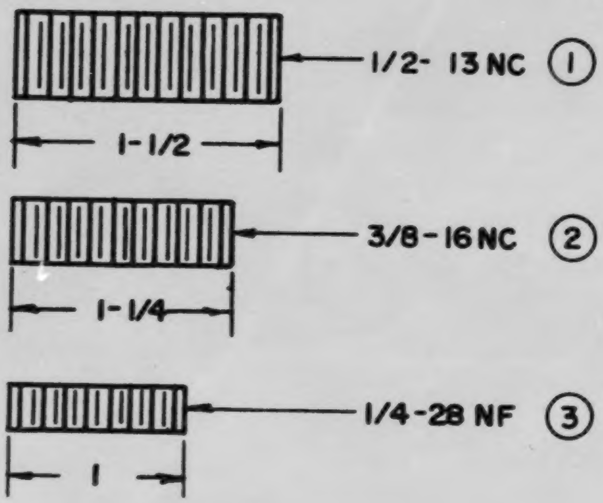
COURSES: Measuring, Bench Work

MATERIALS: One each - Hot Rolled Steel - 1/2" Diameter x 2 1/2" Long

One each - Hot Rolled Steel - 3/8" Diameter x 2 1/4" Long

One each - Hot Rolled Steel - 1/4" Diameter x 2" Long

TASK:	M - 15	Measuring with an outside caliper
	B - 1	Use a bench vice
	B - 5	Use a hand hacksaw
	B - 6	Use a file
	B - 8	Use a die
	M - 1	Measuring with a steel rule


1/2- 13 NC ①
1-1/2
3/8-16 NC ②
1-1/4
1/4-28 NF ③
1

NO.	REQ.	NAME AND OR SIZE	MAT
	1	1/4-28NF HEX NUT	
	1	3/8-16NC HEX NUT	
	1	1/2-13NC HEX NUT	
3	1	1/4" DIA. X 2	
2	1	3/8" DIA. X 2-1/4	
1	1	1/2" DIA. X 2-1/2	CRS

SCALE	REVISIONS	BY	DATE
DATE			
DR'N. GWB · CKD.			
AP'VD.			

TITLE STUDS

NO. 123

6

122

TOLERANCES: DIMENSIONAL ± 1/32, ANGULAR ± 1° ⊥ ± 1/32

STUDS

PROJECT #6

PROCEDURES:

1. Check the size of stock
    a. Use outside caliper
2. Cut stock to the required lengths
    a. Use bench vice
    b. Use hand hacksaw
3. File all corners
4. Thread the rods
    a. Use proper thread series for each rod
    b. Check the fit with a nut and adjust the die if necessary
    c. Cut threads to the full depth to the length
5. Layout the lengths
6. Cut the lengths
7. File the corners
8. Check the lengths
    a. Use outside caliper

MACHINE SHOP

PROJECT #7

TEST BLOCK I

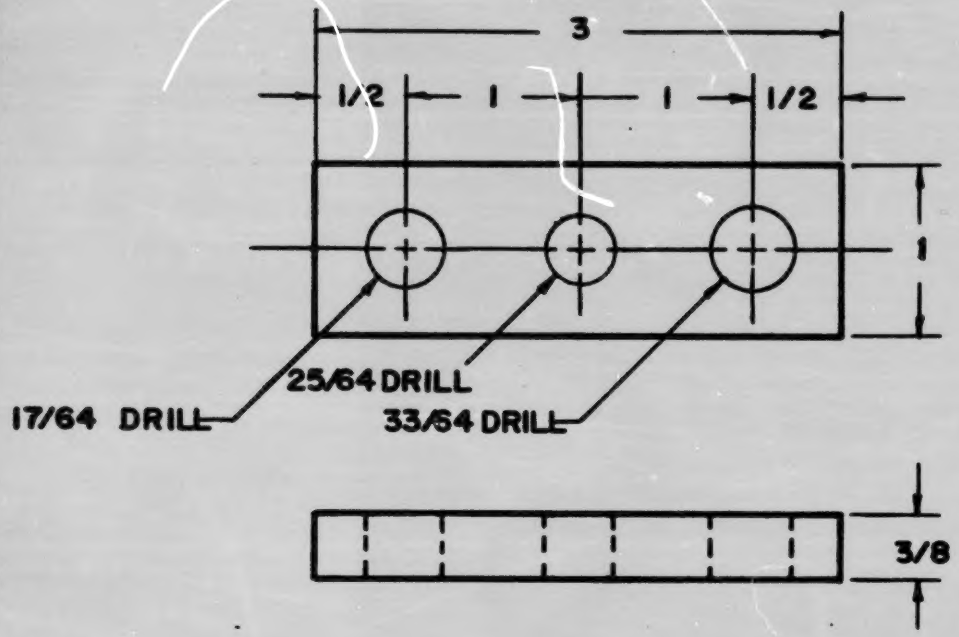
TEST BLOCK I

PROJECT #7

COURSES: Layout, Measuring, Bench Work, Drill Press

MATERIALS: Cold Rolled Steel - 3/8" x 1" x 3 1/2" Long

TASK:	B - 6	Use a file
	L/O - 1	Use a layout table
	M - 1	Measuring with a steel rule
	L/O - 2	Use a scriber
	L/O - 9	Use a center punch
	B - 2	Use a ball-peen punch
	L/O - 8	Use a prick punch
	B - 5	Use a hand hacksaw
	L/O - 11	Use parallels
	D - 8	Center drill on a drill press
	D - 1	Drill on a drill press


3
1/2
1
1
1/2
1
25/64 DRILL
17/64 DRILL
33/64 DRILL
3/8

MATERIAL: 3/8 X 1 X 3 CRS
TOLERANCES: ± 1/32 · ⊥ ± 1/32

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD.			
AP'VD.			

TITLE

TEST BLOCK I 127

NO. 7

TEST BLOCK I

PROJECT #7

PROCEDURES:

1. File one end square
2. Cover with layout blue
3. Layout length and hole locations
4. Center punch hole locations
5. Prick punch length line
6. Cut to length
    a. Use hand hacksaw
7. File the end square and to length
8. Center drill the holes in a drill press
    a. Secure stock in a vice on parallels
9. Drill the holes

MACHINE SHOP

PROJECT #8

T-SLOT CLEANER

T-SLOT CLEANER

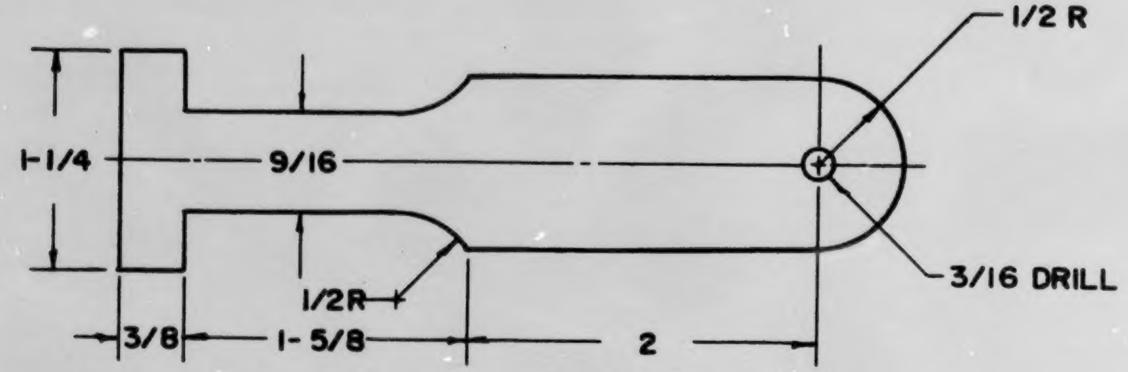
PROJECT #8

COURSES: Measuring, Layout, Bench Work, Saws

MATERIALS: One Each - Hot Rolled Steel Flat 1/8" x 1¼" x 5" Long

TASK:	M - 9	Measure with a slide caliper rule
	B - 5	Using a hacksaw
	B - 6	Using a file
	L/O - 3	Using a combination set
	L/O - 1	Using layout tables
	L/O - 5	Using layout blue
	L/O - 2	Using a scriber
	M - 1	Measuring with a steel rule
	M - 4	Using a rule as a straight edge
	L/O - 6	Using a divider
	L/O - 8	Using a prick punch
	B - 2	Using a ball-peen hammer
	L/O - 10	Using an automatic center punch
	S - 6	Cutting a radius on a vertical band saw
	B - 13	Using an electric hand drill

130


1/2 R
1-1/4
9/16
3/16 DRILL
1/2R
3/8
1-5/8
2

MATERIAL: HRS: 1/8 X 1-1/4 X 5 +- 1/32

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD.			
AP'VD.			

TITLE T- SLOT CLEANER	NO. 132 8

131

BRUNING 40-105

T-SLOT CLEANER

PROJECT #8

PROCEDURES:

1. Check the stock size
    a. Use a slide caliper rule
2. Cut the stock to 4 9/16" long
    a. Use a hand hacksaw
3. File one end square
    a. Use a combination set to check squareness
4. Layout all dimensions
    a. Use a layout table
    b. Use layout blue
    c. Use a steel rule
    d. Use a scriber
    e. Use dividers
5. Punch all layout lines
    a. Use a prick punch
    b. Use a ball-peen hammer
6. Punch the hole location
    a. Use an automatic center punch
7. Cut the project
    a. Use a vertical band saw
8. File to layout line
9. Drill the hole
    a. Use an electric hand drill
10. File all edges

133

MACHINE SHOP

PROJECT #9

DIAL INDICATOR STAND

DIAL INDICATOR STAND

PROJECT #9

COURSES: Measuring, Bench Work, Layout, Drill Presses, Saws

MATERIALS:

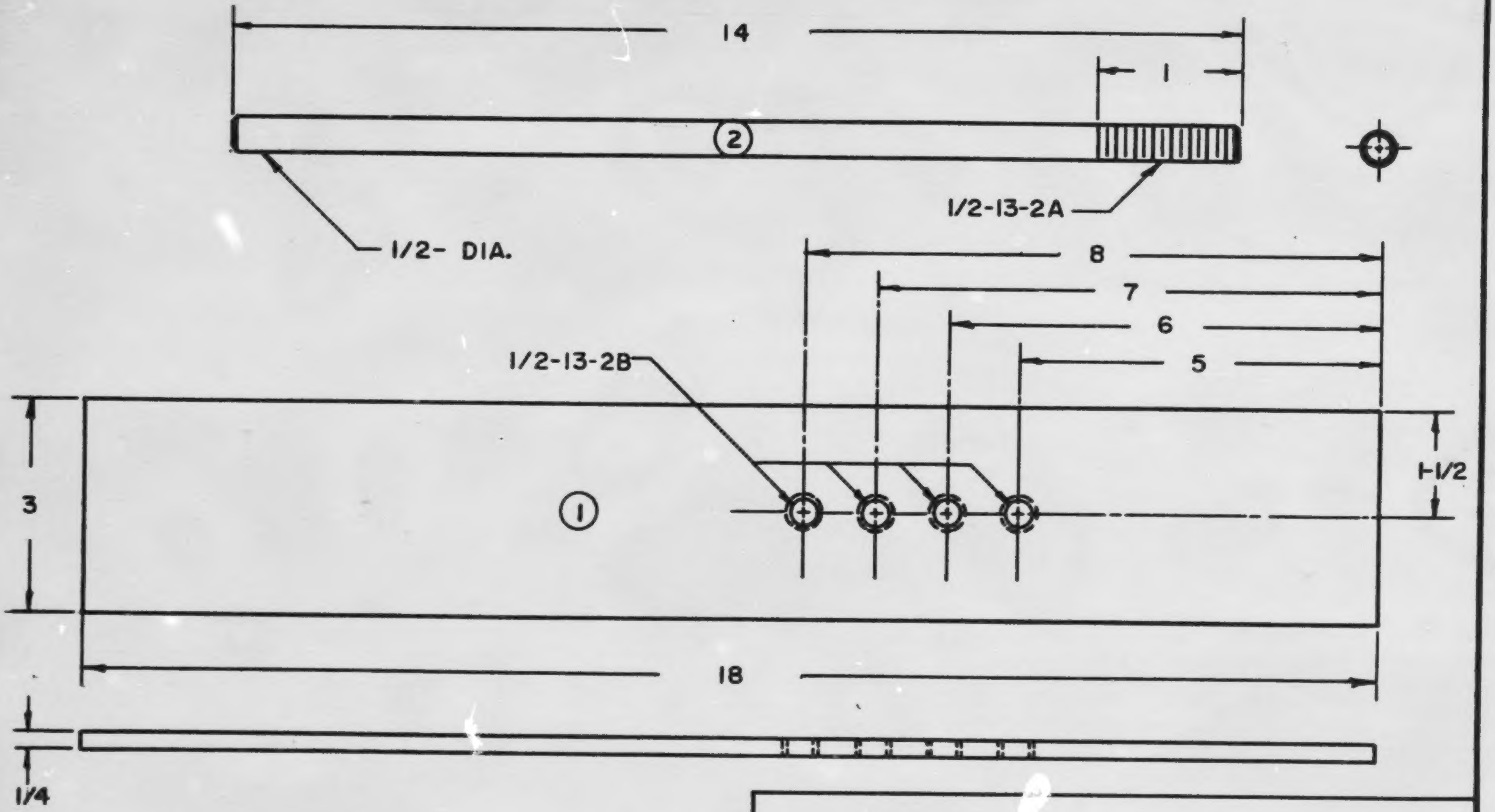
One each - 1/2" x 13" Hex Nut

One each - Hot Rolled Steel Round 1/2" Diameter x 14 1/2" Long

One each - Hot Rolled Steel Flat 1/4" x 3" x 18 1/2" Long

TASK:

M - 9	Measuring with slide caliper rule
M - 7	Measuring with a steel tape
S - 1	Cut to length on a horizontal band or power hacksaw
B - 6	Use a file
B - 8	Use a die
M - 7	Measure with a steel tape
L/O - 5	Use a layout blue
L/O - 3	Use a combination set
L/O - 2	Use a scriber
L/O - 1	Use layout tables
M - 5	Measure using a hook rule
L/O - 9	Use a center punch
D - 1	Drill on a drill press
D - 7	Tapping on a drill press


14
1
2
1/2- DIA.
1/2-13-2A
8
7
6
5
1/2-13-2B
3
1
1-1/2
18
1/4

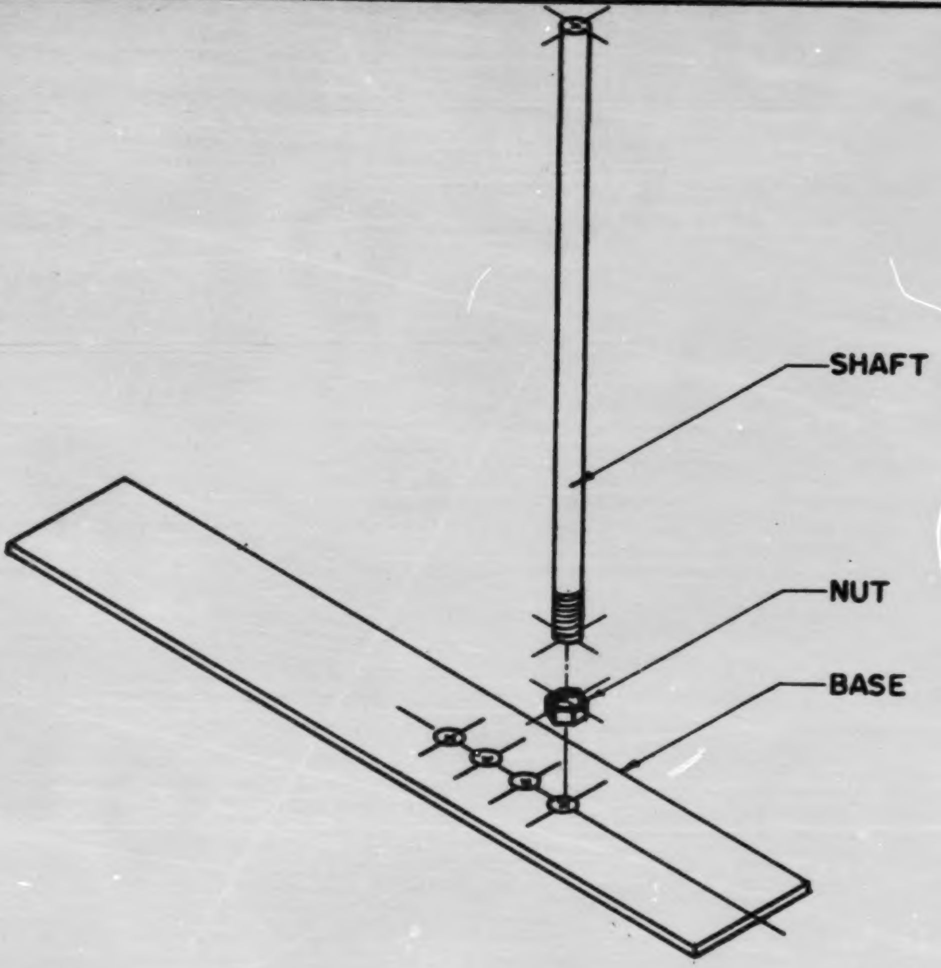
TOLERANCES: DIMENSIONAL: ±1/32 · ±⊥ 1/32

3	1	1/2-13 HEX NUT (NOT SHOWN)	HRS
2	1	1/2 DIA. X 14	HRS
1	1	1/4 X 3 X 18	HRS
NO.	REQ'D	DESCRIPTION AND SIZE	MAT

SCALE 1/2 SIZE	REVISIONS	BY	DATE
DATE			
DRN. GWB · CKD.			
AP'VD.			

TITLE
DIAL INDICATOR STAND

NO. 9
1 OF 2


SHAFT
NUT
BASE

SCALE QTR. SIZE	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD.			
AP'VD.			

TITLE
DIAL INDICATOR STAND ASSEMBLY

NO. 9

2 OF 2

DIAL INDICATOR STAND

PROJECT #9

PROCEDURES: SHAFT

1. Select 1/2" round stock using slide caliper rule
2. Cut to length on power hacksaw
3. File all corners
4. Thread round stock

BASE

5. Cut to length on a horizontal band saw
    a. Allow enough for filing
6. File to length and square
7. Coat with layout blue
8. With square head, scribe the center line parallel to long edge on a layout table
9. Use a hook rule and layout the hole locations
10. Center punch the hole locations
11. Drill the holes to be tapped
12. Tap the drilled holes
13. File all edges smooth

REFERENCES

1. Krar, S. F. and Oswald, J. W.: Grinding Technology. Albany: Delmar Publishers, 1974.

2. Lascoe, Nelson, Porter: Machine Shop - Operations and Setups. Chicago: American Technical Society, 1973

3. Oberg, Erik and Jones, F. D.: Machinery's Handbook. New York, N.Y.: Industrial Press Inc., 1976

4. Morse: Machinist's Practical Guide. New Bedford, Mass: Morse Cutting Tools Division, 1978

5. Krar, S.F.; Oswald, J. W. and St. Amond, J. E.: Technology of Machine Tools. New York: McGraw-Hill Book Company, Gregg Division, 1977

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Title VI - Peyton Williams Jr., Associate Superintendent of State Schools and Special Services
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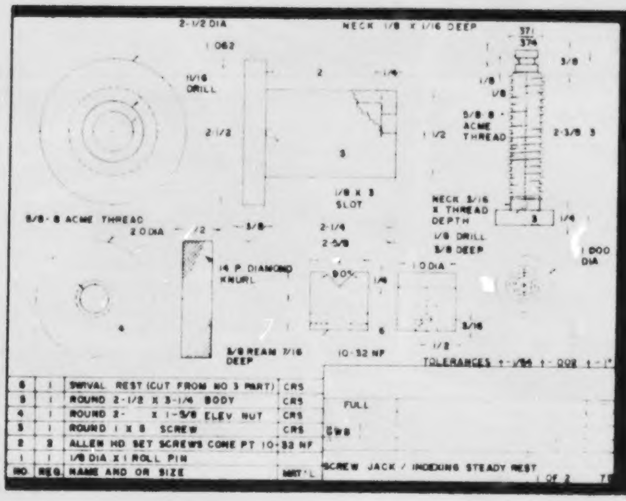
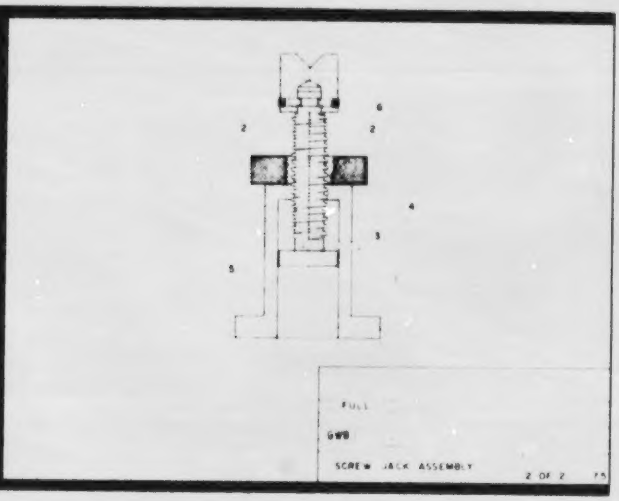
MACHINE SHOP PROJECTS

MEASURING, LAYOUT, BENCH WORK, SAWS
Projects 10-14

DRILL PRESSES
Projects 15-18


2-1/2 DIA
1.062
NECK 1/8 X 1/16 DEEP
1/16 DRILL
2-1/2
1/8 X 3 SLOT
5/8-8 ACME THREAD
5/8-8 ACME THREAD
NECK 3/16 X THREAD DEPTH
1/8 DRILL
3/8 DEEP
14 P DIAMOND KNURL
1.000 DIA
3/8 REAM 7/16 DEEP
10-32 NF
TOLERANCES ±-1/64 ±-.002 ±-1°
6 | 1 | SWIVAL REST (CUT FROM NO 3 PART) | CRS
5 | 1 | ROUND 2-1/2 X 3-1/4 BODY | CRS
4 | 1 | ROUND 2- X 1-5/8 ELEV NUT | CRS
3 | 1 | ROUND 1 X 6 SCREW | CRS
2 | 2 | ALLEN HD SET SCREWS CONE PT 10-32 NF
1 | 1 | 1/8 DIA X 1 ROLL PIN
NO. | REQ. | NAME AND OR SIZE | MAT'L
FULL
SWB
SCREW JACK / INDEXING STEADY REST
1 OF 2


FULL
SWB
SCREW JACK ASSEMBLY
2 OF 2

STUDENT MANUAL

Georgia Department of Education

MACHINE SHOP PROJECTS

Developed Under a Grant from

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1980

This project was developed under a grant from:

Division of Program Development
Office of Vocational Education
Georgia Department of Education

Project Numbers: 98251 and 28252

to:
Augusta Area Vocational-Technical School

Author:
Raymond E. Westbrook
Instructor, Machine Shop

Drawings:
George W. Baggs, Jr.
Instructor, Drafting and Design

TABLE OF CONTENTS

TITLE

Part A: PURPOSE

Part B: PROJECT LISTING (Categorized)

Part C: PROJECTS - 1-101:

Cover Sheet
Information Sheet
Project Drawings
Fabrication Procedures

Part D: REFERENCES

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Part D: REFERENCES

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PURPOSE

A student in Machine Shop must learn by doing. Although lectures, reading assignments, and audio-visual aids are very necessary, these methods alone will never produce a good machinist. The combination of both classroom and shop practice is essential to your training. The purpose of this Shop Project Guide is to give the necessary shop experience to complement your classroom training. This guide is based on the author's years of practical experience as a skilled machinist and as a teacher in the field. Each skill needed to complete a phase of your training has been identified. Next, projects have been devised to give hands-on experience for each skill with enough repetition so that you will become capable of using each tool or attachment for the particular machine or operation being taught. Your instructor will help you select or will assign the projects in the necessary order. You will also find the end products of these projects will be useful tools that will help in your training that follows. This serves not only to make the projects more interesting, but more enjoyable to construct. This practical training along with classroom instruction and applied learning can bring you a rewarding future as a skilled tradesman.

PROJECT LISTING (CATEGORIZED)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench
*11. Pipe flange assembly
*12. C-clamp
*13. Block and tackle
*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects
*16. Jack Stand
*17. Gear puller
18. Tool post base

MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (genreal purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. 1/4" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
40. Dead center
41. Plumb bob

42. Dumbbell set
43. Taper plug gage
44. Rocker dish
45. Rocker
46. Tool post body
47. Circle cutter
48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II
*50. Fly cutter
51. Tooth pick holder
*52. Pipe center
53. Taper ring gage
54. Set up bolt 1/2" x 4"
55. Set up bolt 1/2" x 6"
56. Set up bolt 1/2" x 8"
57. Set up bolt 3/8" x 4"
58. Set up bolt 3/8" x 6"
59. Drill reducer
60. Tap drill extension (1/4" - 20 NC tap drill)
61. Tap drill extension (5/16" - 18 NC tap drill)
62. Boring bar holder body jig
63. Boring bar holder body
*64. Boring bar holder base
65. Boring bar holder inner body
66. Boring bar holder base jig

67. Precision measuring tool block
*68. Milling arbor #40 - 3/8"
*69. Milling arbor #40 - 1/5"
*70. Milling arbor #40 - 5/8"
*71. Milling arbor #40 - 3/4"
*72. Lathe arbor
73. Mallet
74. Acme thread/boring tool
*75. Screw jack/indexing steady rest
76. Lathe chuck wrench
77. Internal pipe wrench
78. Buffer/grinder shaft

SHAPER

79. Splitting wedge
80. Flat strap clamp
*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks I
*83. V-blocks
84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge
86. Solid key seat
87. Water valve wrench
88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. 1/4" pitch, 1' lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

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MACHINE SHOP

PROJECT #10

TAP WRENCH

TAP WRENCH

PROJECT #10

COURSES: Measuring, Layout Work, Bench Work, Drill Presses, Saws

MATERIALS:

Two each - Cold rolled square 5/8" x 3 1/2" long

Two each - Cold rolled round 3/8" diameter x 5" long

One each - Cold rolled round 1/4" diameter x 1 3/4" long

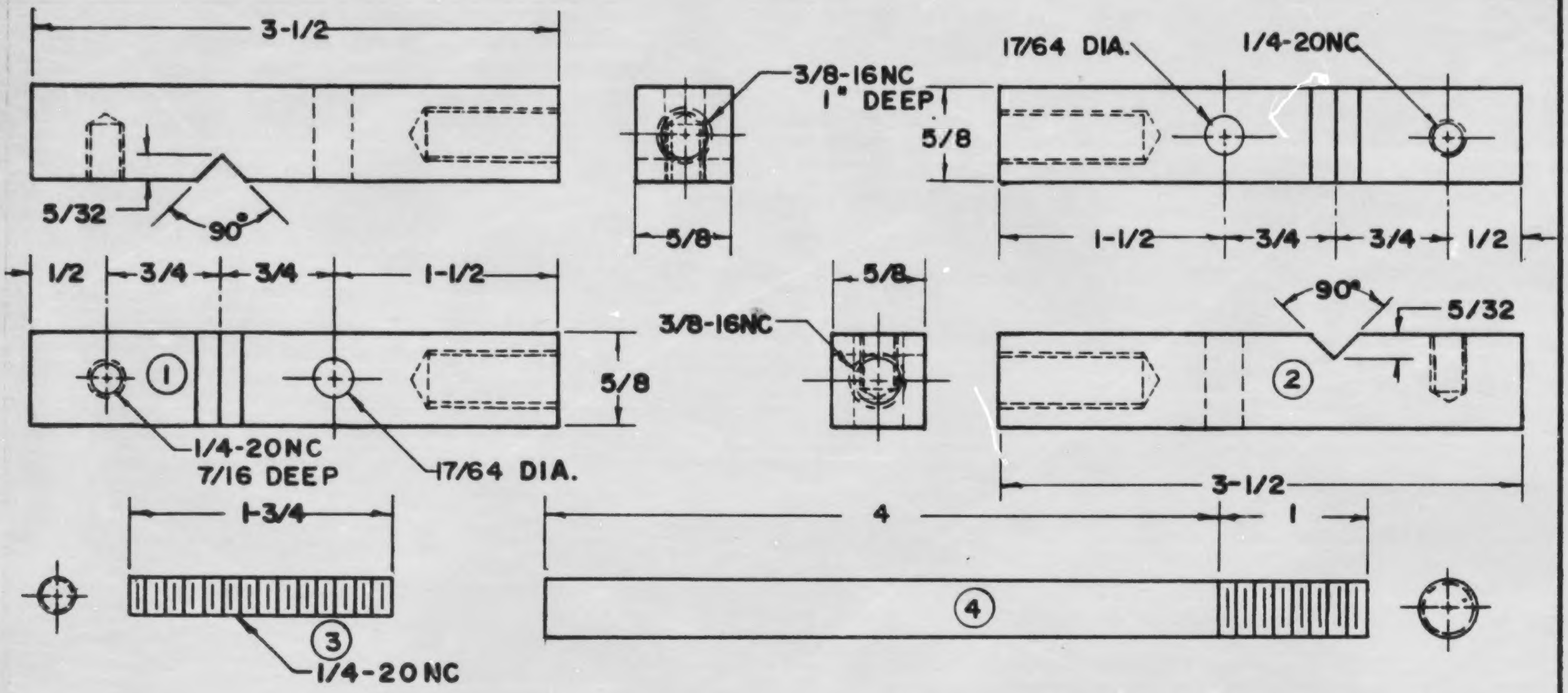
Two each - 1/4 lock washers

Two each - 1/4-20 wing nuts

TASK:

M - 15	Measuring with an outside caliper
B - 8	Use a die
B - 5	Use a hand hacksaw
B - 1	Use a bench vice
B - 6	Use a file
S - 1	Cut to length on a horizontal band or power hacksaw
M - 5	Measuring using a hook rule
L/0 - 2	Use a scriber
L/0 - 5	Use layout blue
M - 1	Measuring with a steel rule
L/0 - 9	Use a center punch
L/0 - 8	Use a prick punch
L/0 - 3	Use a combination set
M - 4	Use a rule as a straight edge
B - 7	Use a tap
D - 1	Drill on a drill press

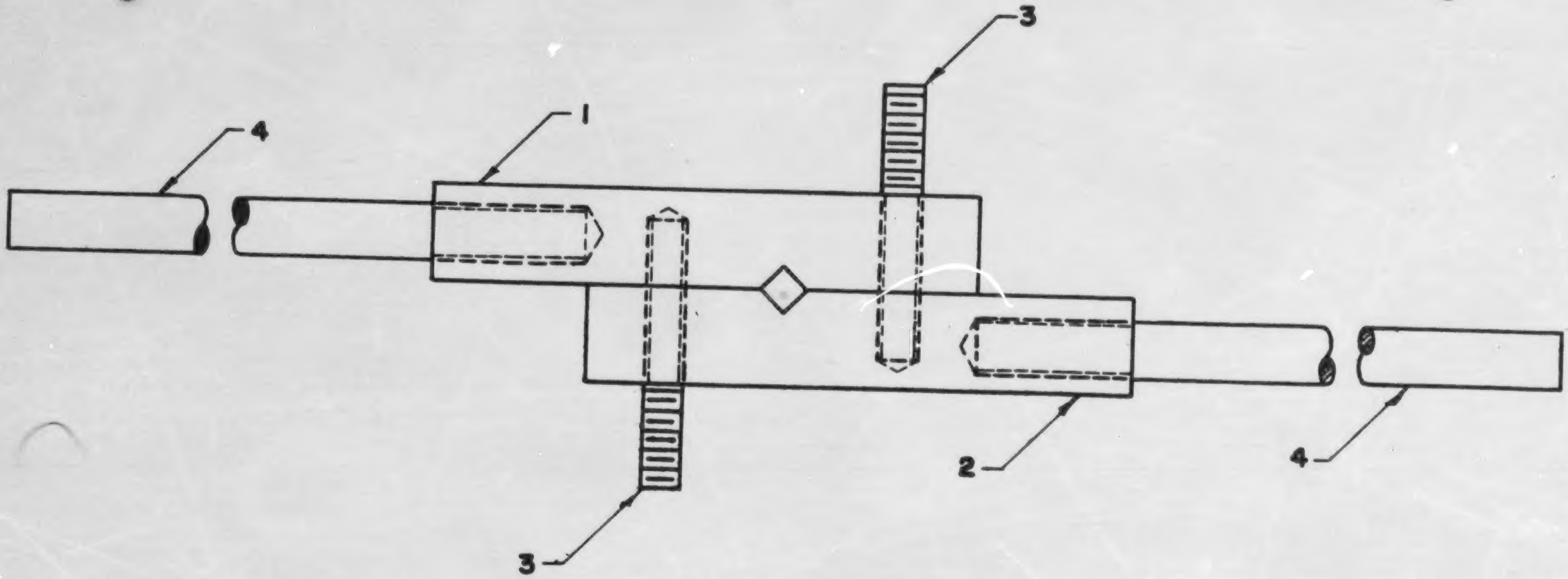
D - 7	Tap on a drill press
D - 6	Spot face on a drill press
S - 3	Cut an angle on a vertical band saw
B - 12	Use a letter and/or number punch set


3-1/2
3/8-16NC
1" DEEP
5/8
17/64 DIA.
1/4-20NC
5/32
90°
5/8
1-1/2
3/4
3/4
1/2
1/2
3/4
3/4
1-1/2
5/8
3/8-16NC
90°
5/32
①
5/8
②
1/4-20NC
7/16 DEEP
17/64 DIA.
3-1/2
1-3/4
4
1
④
③
1/4-20NC

TOLERANCES: · ± 1/32 · ±1°

N	REQ.	NAME AND OR SIZE	MAT.
6	2	1/4 WING NUTS (NOT SHOWN)	
5	2	1/4 LOCK WASHER (NOT SHOWN)	
4	2	3/8 DIA. X 5	CRS
3	2	1/4 DIA. X 1-3/4	CRS
2	1	5/8 SQ. X 3-1/2	CRS
1	1	5/8 SQ. X 3-1/2	CRS

SCALE FULL
REVISIONS
BY
DATE
DATE
DR N GWB
CKD
AP VD
TITLE TAP WRENCH PARTS
NO. 10
OF 2



5

BRUNING 40-105

160

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB | CKD.			
AP'VD.			

TITLE

TAP WRENCH ASSEMBLY

NO 10

161 2 OF 2

TAP WRENCH

PROJECT #10

PROCEDURES: STUDS

1. Use outside caliper to check 1/4" stock
    a. Use one piece of stock 4 1/2" long and thread with a die, then cut two pieces 1 3/4" long
2. File all edges

HANDLES

3. Cut to length
4. Cut the threads
5. File all edges

TAP BODY

6. Check stock size using a hook rule
7. Layout 1/4" tapped hole
8. Layout drilled holes with block rule method and center punch
9. Locate center of "V"
10. Locate depth of "V"
11. Layout "V" and prick punch
12. Layout both pieces together and check your layout
13. Layout the threaded holes in the end using a rule as a straight edge
14. Drill and tap all holes
15. Spot face for lock washers
16. Use a vertical band saw and cut the angles
17. File the angles
18. File all edges
19. Stamp your initials on the tap body

20. Assemble the project

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MACHINE SHOP

PROJECT #11

PIPE FLANGE ASSEMBLY

164

PIPE FLANGE ASSEMBLY

PROJECT #11

COURSES: Layout, Measuring, Bench Work, Drill Presses, Saws, Lathes

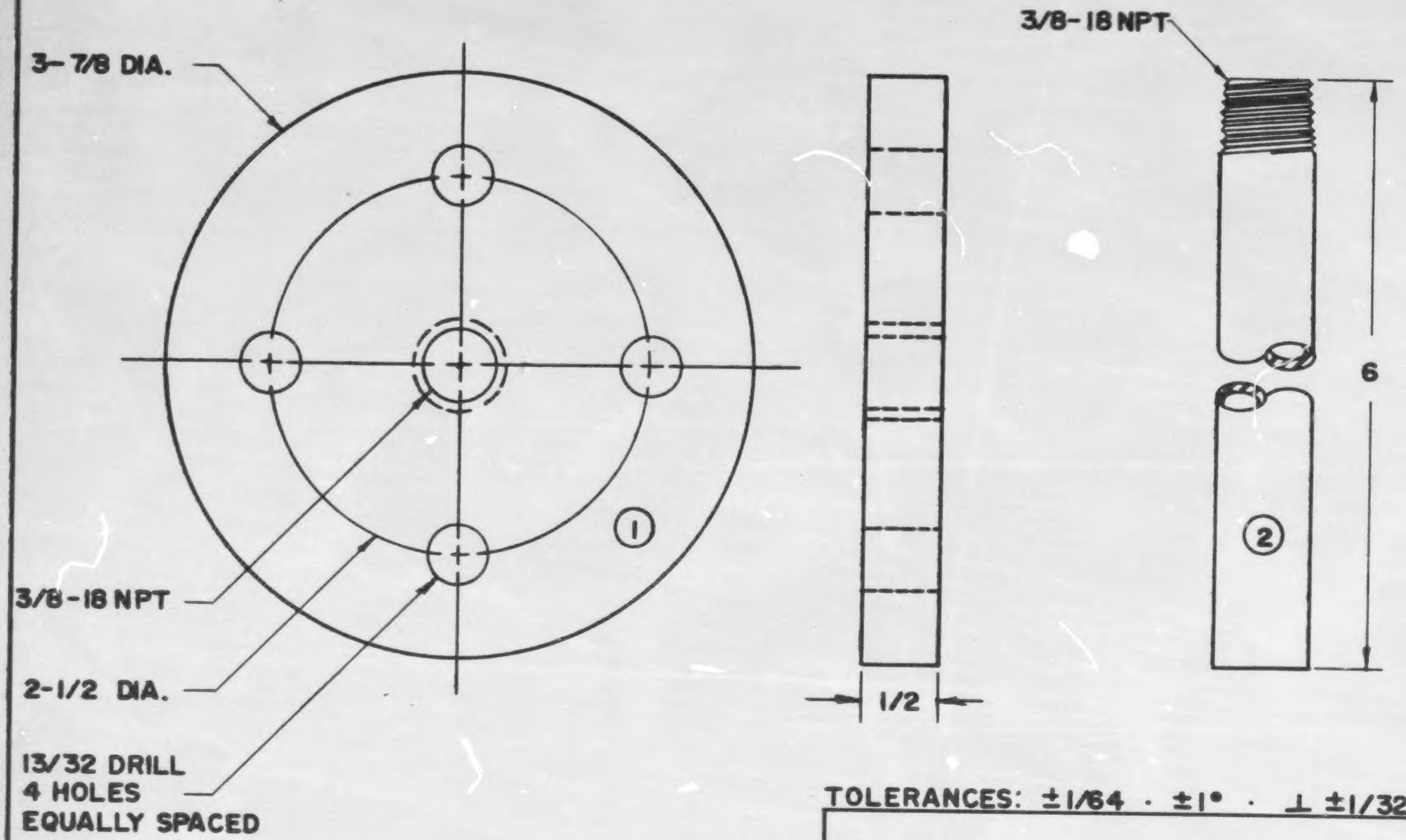
MATERIALS: Two each - Black Iron Pipe 3/8" x 6 1/2"

Two each - Cold Rolled Flat 4" x 4" x 1/2"

TASK:

M - 16	Measuring with inside calipers
M - 1	Measuring with a steel rule
M - 9	Measuring with slide caliper rule
S - 1	Cut to length on a horizontal band or power hacksaw
L/0 - 6	Use a divider
M - 4	Using a rule as a straight edge
L/0 - 8	Use a prick punch
L/0 - 9	Use a center punch
S - 5	Cut a circle on a vertical band saw
D - 1	Drill on a drill press
B - 14	Use a chisel
B - 7	Use a tap
L - 6	Chucking with a three-jaw chuck
L - 8	Facing in a lathe
L - 21	Grind a V-threading tool
L - 22	Cutting an external V-thread in a lathe
L - 29	Cutting a taper with the taper attachment
L/0 - 2	Use a scriber
D - 8	Center drill on a drill press

D - 7	Tapping on a drill press
L - 9	Turning in a lathe
M - 15	Measuring with an outside caliper


3/8-18 NPT
3-7/8 DIA.
①
3/8-18 NPT
2-1/2 DIA.
13/32 DRILL
4 HOLES
EQUALLY SPACED
1/2
6
②

TOLERANCES: ±1/64 · ±1° · ⊥ ±1/32

2	2	3/8 X 6 BLACK IRON PIPE		
1	2	4X 4X 1/2 FLAT	CRS	
NO.	REQ.	NAME AND OR SIZE	MAT.	

167

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB | CKD.			
AP'VD.			
TITLE PIPE FLANGE ASSEMBLY PARTS	NO. 168		

11

PIPE FLANGE ASSEMBLY

PROJECT #11

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills

PROCEDURES: 1. Check all materials for proper size

Pipe #1

2. Cut the pipe to length
3. Use NPT die and thread

Flange #1

4. Layout outside diameter
    a. Use dividers
5. Layout hole circle
    a. Use dividers
6. Layout the four holes
    a. Use straight edge
    b. Use dividers
7. Prick punch outside diameter
8. Center punch all hole locations
9. Circle all holes to their diameters
    a. Use a divider
10. Cut the outside diameter
    a. Use a vertical band saw
11. Drill the holes
    a. Draw the drill if necessary

12. Tap the center hole
    - a. 3/8" x 18 NPT tap

Pipe #2

13. Cut to length
    - a. Allow 1/8" per saw cut
14. Chuck stock in a three-jaw chuck
15. Face both ends
16. Cut the threads
    - a. A bolt and pipe threading machine may be used if available
    - b. Threads may be cut on the lathe using
        - (1) Pipe center
        - (2) Taper attachment
        - (3) 60 V-threading tool
        - (4) Thread cutting set-up
        - (5) Chamfer to thread depth

Flange #2

17. Locate the center of the square
    - a. Use the rule as a straight edge
    - b. Scribe line from corner to corner
    - c. Prick punch the center
18. Scribe the hole circle
    - a. Use dividers
19. Center the rotary table on the drill press
20. Center the flange on the rotary table

Center Drill

21. Drill and tap the center hole
22. Locate the center of the spindle on the hole circle

23. Zero the rotary table
24. Center drill and drill the first hole
25. Turn the rotary table 1/4 turn or 90°
26. Repeat until all holes are drilled
27. Screw pipe in threaded hole
28. Chuck in lathe on the pipe
    a. Use a three-jaw chuck
29. Turn to outside diameter of the flange
    a. Check with outside caliper
30. Chamfer all edges

MACHINE SHOP

PROJECT #12

C-CLAMP

C-CLAMP

PROJECT #12

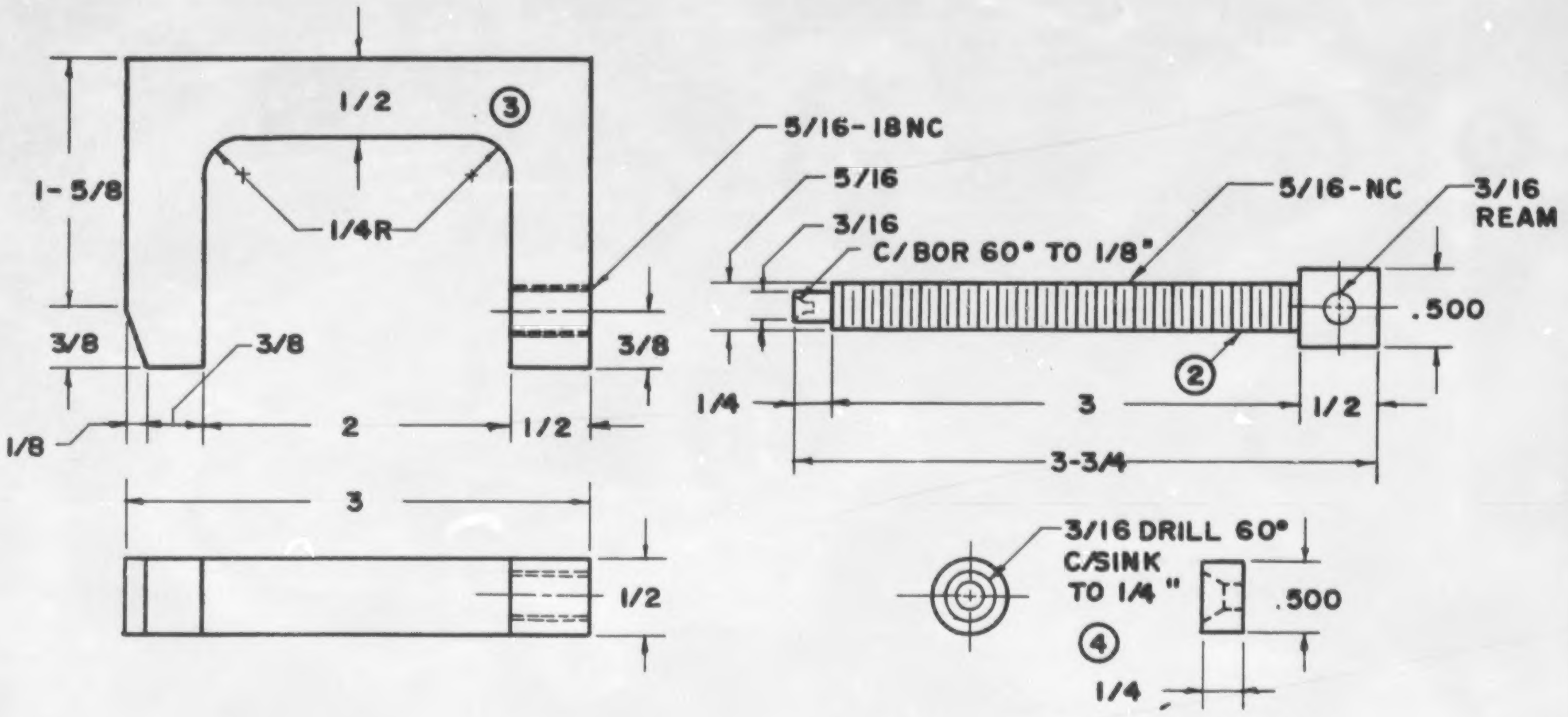
COURSES: Measuring, Bench Work, Layout, Saws, Drills, Lathes

MATERIALS: One each - Cold Rolled Steel Flat 1/2" x 2" x 3 1/8" Long
One each - Cold Rolled Steel Round 1/2" Diameter x 5" Long
One each - Roll Pin 3/16" Diameter x 2" Long

TASK:

M - 9	Measuring with a slide caliper rule
B - 6	Using a file
L/O - 5	Using a layout blue
L/O - 3	Using a combination set
L/O - 2	Using a scriber
L/O - 8	Using a prick punch
B - 1	Using a bench vice
L/O - 9	Using a center punch
L/O - 6	Using a divider
M - 4	Using a rule as a straight edge
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press
M - 30	Measuring with an outside micrometer caliper
S - 1	Cutting to length
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 4	Grinding a facing tool
L - 10	Center drilling in a lathe

L - 11	Drilling in a lathe
L - 16	Grinding a general purpose lathe tool
L - 9	Turning in a lathe
L - 14	Turning a shoulder in a lathe
B - 8	Use a die
L/O - 10	Use an automatic center punch
B - 2	Use a ball-peen hammer


1/2
③
1-5/8
1/4R
3/8
3/8
3/8
1/8
2
1/2
3
1/2
5/16-18NC
5/16
3/16
C/BOR 60° TO 1/8"
5/16-NC
3/16
REAM
.500
②
1/4
3
1/2
3-3/4
3/16 DRILL 60°
C/SINK
TO 1/4"
④
.500
1/4

TOLERANCES: +- 1/32 · +- .005 · +-1°

① ROLL PIN NOT SHOWN

175

4	1	SWIVEL BASE	CRS
3	1	BODY FLAT 1/2 x 2 x 3-1/8	CRS
2	1	ROUND 1/2 DIA. x 5(BOLT)	CRS
1	1	ROLL PIN 3/16 DIA x 2	CRS
NO.	REQ.	NAME AND OR SIZE	MAT.

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD			
AP'VD			

TITLE C-CLAMP

NO. 176

BRUNING 40-105

C-CLAMP

PROJECT #12

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills

PROCEDURES: **BODY**

1. Check size of stock
   a. Use a slide caliper rule
2. File one end square
3. Layout length
   a. Use layout blue
   b. Use a combination set
   c. Use a scriber
4. Prick punch the layout line
   a. Use a prick punch
5. Secure stock in a bench vice
6. Cut to length
   a. Use a hand hacksaw
   b. Leave 1/32" to file
7. File to length
8. Layout the center of the inside radii and center punch
   a. Use layout blue
   b. Use a combination square head
   c. Use a scriber
   d. Use a center punch
   e. Use a divider

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9. Layout the angle
    a. Use a steel rule
    b. Use a scriber
10. Layout the hole to be tapped
    a. Use a combination set
    b. Use a scriber
    c. Use layout blue
11. Drill the radii
12. Drill and tap the 5/16 - 18 NC
13. Layout the legs and punch the lines
    a. Use a scale
    b. Use a scriber
14. Cut the legs
    a. Use a hand hacksaw
15. File the legs
16. File the angle
17. File all edges slightly
18. Remove all layout blue

SWIVEL BASE

19. Check round stock for size
    a. Use an outside micrometer
20. Cut the stock
    a. Use a horizontal band saw or power hacksaw
    b. Cut to 5" long
21. Chuck the stock in a lathe
    a. Use a three-jaw chuck
    b. Have 1 1/2" out of the chuck
22. Face the stock

    a. Grind a facing tool

23. Center drill

    a. Use a #2 center drill

24. Drill

    a. Drill 7/16" deep

25. Chamfer the edges

26. Cut-off

    a. Use a cut-off tool in the lathe

T-BOLT

27. With the stock in the lathe from the swivel base, face the stock

28. Center drill

    a. Use a center drill to counter bore the small end

29. Remove the stock from the lathe

30. Layout the length

31. Cut to length

    a. Use a horizontal band or power hacksaw

    b. Allow 1/8" for facing

32. Return to the lathe and face to length

33. Reverse ends

    a. Chuck on 3/8" of stock

    b. Insert the center in the pre-center drilled hole

34. Turn the 5/16" diameter

    a. File to .003" under 5/16"

        (1) Use a lathe file

        (2) Use an outside micrometer

    b. Grind a general purpose tool

35. Face the shoulder
36. Turn the .312 diameter (3/16")
37. Cut the threads
    a. Use a die stock and die
38. Chamfer all edges
39. Remove from lathe
40. Layout the T-handle hole
41. Center punch
    a. Use an automatic center punch
42. Drill and ream the 3/16" hole
43. Chamfer all edges
44. Remove the layout blue

ASSEMBLY

Insert roll pin in the T-bolt. Screw the T-bolt in the body. Mount the swivel base and brad with a ball-peen hammer and center punch.

MACHINE SHOP

PROJECT #13

BLOCK AND TACKLE

BLOCK AND TACKLE

PROJECT #13

COURSES: Measuring, Layout Work, Bench Work, Saws, Lathe

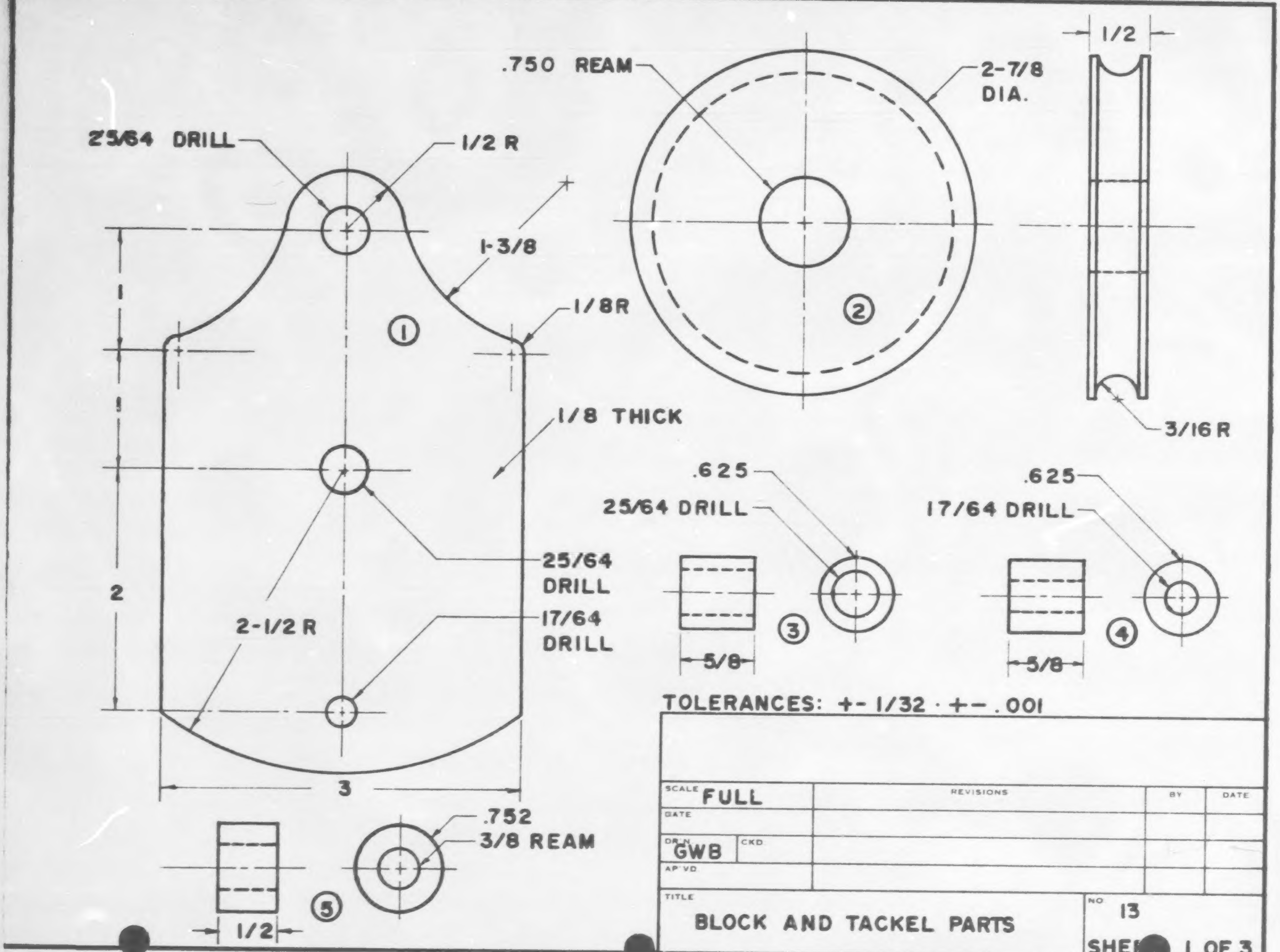
MATERIALS:

Five Each - Hot Rolled Steel Flats 1/8" x 3" x 5½" Long
Three Each - Hot Rolled Steel Round 3" diameter x 1" Long
One Each - Cold Rolled Steel Round 5/8" diameter x 5" Long
One Each - Brass Free Machining Round 1" diameter x 5" Long
Two Each - 3/8-16 Bolts 2" Long
Two Each - 3/8-16 Bolts 1½" Long
Four Each - 3/8-16 Nuts
Eight Each - 3/8 Flat Washers
Four Each - 3/8 Lock Washers
One Each - 1/4-20 Bolt 2" Long
One Each - 1/4-20 Bolt 1½" Long
Four Each - 1/4 Flat Washers
Two Each - 1/4 Lock Washers
Two Each - 1/4-20 Nuts

TASK:

M - 9	Measuring with a slide caliper rule
L/O - 5	Use layout blue
L/O - 3	Use a combination set
L/O - 2	Use a scriber
L/O - 8	Use a prick punch
S - 6	Cutting a radius on a vertical band saw
S - 3	Cutting an angle on a vertical band saw
B - 6	Use a file

L - 4	Grind a facing tool
L - 1	Grind a general purpose lathe tool
M - 18	Measuring with a radius and fillet gage
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
L - 27	Use a mandrel in a lathe
L - 13	Turn work between centers
M - 30	Measuring with an outside micrometer
L - 17	Filing in a lathe
L - 16	Cutting-off in a lathe
B - 10	Use an arbor press
B - 9	Use a hand reamer


25/64 DRILL
1/2 R
1-3/8
1/8R
①
1/8 THICK
25/64
DRILL
17/64
DRILL
2-1/2 R
1
1
2
3
.750 REAM
2-7/8
DIA.
②
1/2
3/16 R
.625
25/64 DRILL
③
5/8
.625
17/64 DRILL
④
5/8
.752
3/8 REAM
⑤
1/2

TOLERANCES: +- 1/32 · +- .001

SCALE FULL
DATE
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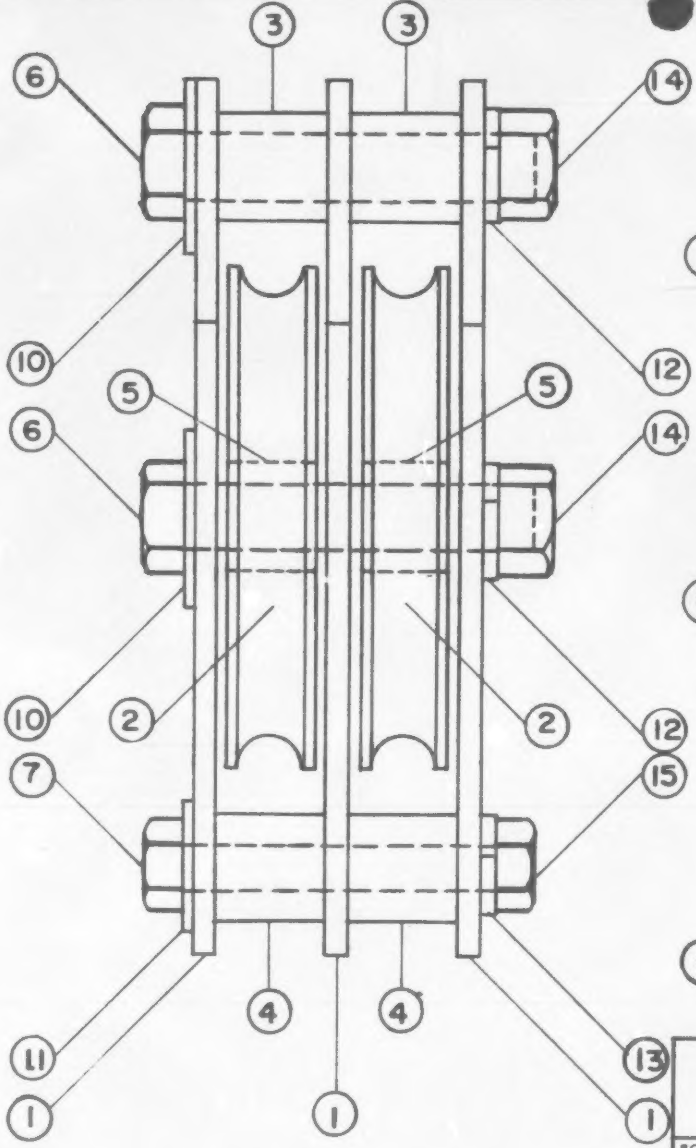
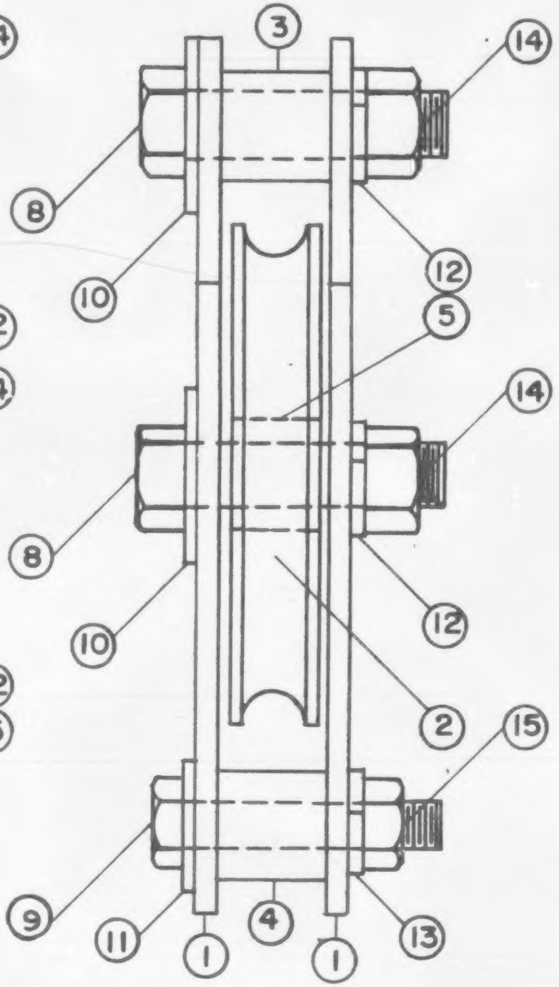
CKD
AP'VD
REVISIONS
BY
DATE

TITLE
BLOCK AND TACKEL PARTS

NO 13
SHE[illegible] 1 OF 3


3
3
6
14
10
12
5
5
6
14
10
2
2
12
7
15
11
1
4
4
1
13
1


3
14
8
10
12
5
14
8
10
12
2
15
9
11
1
4
1
13

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DATE			
DR'N GWB / CKD			
AP'VD			

TITLE
BLOCK AND TACKEL ASSEMBLY

NO. 13
SHEET 2 OF 3

BRUNING 40-105

NOTES:

1. PLATES TO BE CUT FROM 3 X 5-1/2 X 1/8.
2. PULLIES TO BE CUT FROM 3 PIECES 3" DIA. X 3/4" LONG.
3. SPACERS TO BE CUT FROM ONE PIECE 5/8 DIA. X 5" LONG.
4. BEARINGS TO BE CUT FROM 1" DIA. X 5" LONG BRASS FREE MACHING ROUND.

NO.	REQ.	NAME AND OR SIZE	MAT.	
15	2	1/4-20 NUTS		
14	4	3/8-16 NUTS		
13	2	1/4 LOCK WASHERS		
12	4	3/8 LOCK WASHERS		
11	2	1/4 FLAT WASHERS		
10	4	3/8 FLAT WASHERS		
9	1	1/4-20 HEX BOLT 1-1/2LONG		
8	2	3/8-16 HEX BOLT 1-1/2"LONG		
7	1	1/4-20 HEX BOLT 2" LONG		
6	2	3/8-16 HEX BOLT 2" LONG		
5	3	.752 DIA. X 1/2"LONG	BRASS	(NOTE 4)
4	3	.625 DIA. X 5/8" LONG	CRS	(NOTE 3)
3	3	.625 DIA. X 5/8 LONG	CRS	(NOTE 3)
2	3	2-7/8 DIA. X 1/2 LONG	HRS	(NOTE 2)
1	5	3 X 5 X 1/8 FLAT	HRS	(NOTE 1)

SCALE	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD			
AP'VD			

TITLE
BLOCK AND TACKEL BILL OF MATERIALS

NO 13
SHEET 3 OF 3

BLOCK AND TACKLE

PROJECT #13

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCEDURES: PLATES

1. Check the stock size
2. Layout all hole locations and prick punch them
    a. Use layout blue
    b. Use a combination set
    c. Use a scriber
    d. Use a prick punch
3. Layout all radii
    a. Use a divider
4. Prick punch all layout lines
5. Cut the 1 3/8"R and the 2½"R on the vertical band saw
6. Rough cut the small radii
7. File all small radii
8. Center punch the drill hole locations
9. File all edges

PULLEY

10. Grind a facing tool
11. Grind a general purpose lathe tool
12. Grind a 3/16" radius tool
    a. Use a radius and fillet gage
13. Chuck on the 3" round stock in a three-jaw chuck in a lathe
14. Face stock square
15. Center drill the work

190

16. Drill the hole to be reamed

17. Ream the hole

18. Reverse the piece in the lathe

    a. Be sure the faced piece is parallel with the face of the chuck

19. Face to width

20. Mount pulley on a mandrel

21. Mount the mandrel between centers

22. Turn to 2 7/8

    a. Check diameter with a micrometer

23. Form the radius

24. Chamfer all edges

BEARING

25. Chuck 1" diameter brass

    a. Use a three-jaw chuck

26. Face the brass stock

27. Center drill

28. Insert a bearing center

29. Turn stock to .780" - 3" Long

30. Drill for reamed hole

31. Ream the hole

32. Finish turning to .752"

33. Chamfer edge

    a. Use a file

34. Start to cut off

    a. Use a cut-off tool

35. File chamfer before cutting off

36. Finish cutting off

37. Repeat until all bearing are finished

38. Press bearings in pullies
    a. Use arbor press
39. Use hand reamer
    a. After pressing bearings

SPACER

40. Chuck 5/8" diameter stock
    a. Chuck in a three-jaw chuck
41. Face end
42. Center drill
43. Drill with 17/64" drill
44. Cut to length
    a. Cut 3 each spaces
45. Re-drill with 25/64" drill
46. Cut to length
    a. Cut 3 each spacers
47. Chamfer all edges
48. Assemble project

MACHINE SHOP

PROJECT #14

STEEL BEAM TRAMMEL

STEEL BEAM TRAMMEL

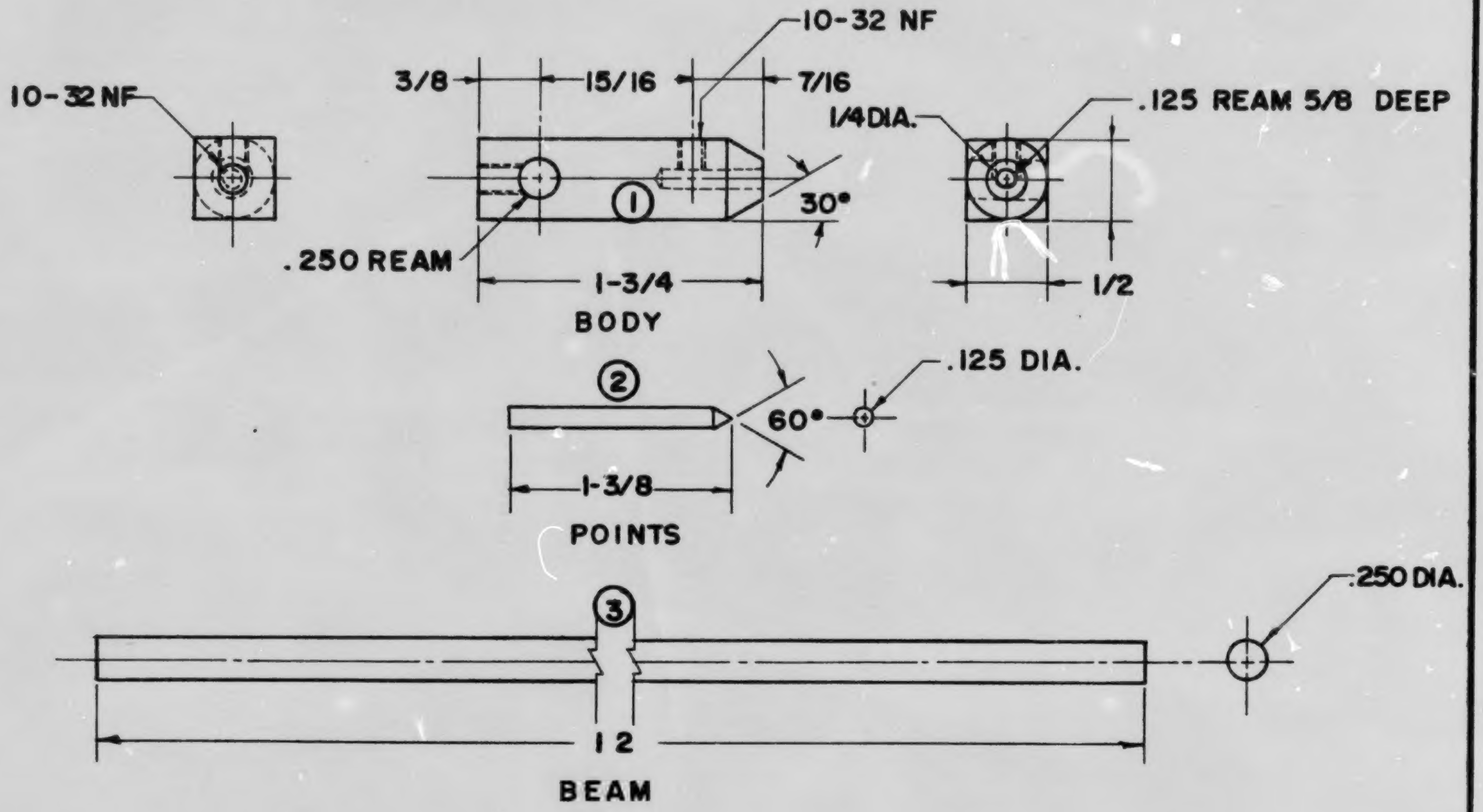
PROJECT #14

COURSES: Measuring, Layout, Bench Work, Saws, Drills, Lathe

MATERIALS: Two Each - Cold Rolled Square ½" x ½" x 2"
Two Each - Drill Rod Round 1/8" diameter x 1½" Long
One Each - Cold Rolled Round ¼" diameter x 13" Long
Four Each - Set Screws 10 -32 - 3/16" Long

TASK:

M - 34	Measuring with a vernier caliper
M - 1	Measuring with a steel rule
L/O - 5	Use layout blue
L/O - 2	Use a scriber
B - 5	Use a hand hacksaw
B - 6	Use a file
L - 6	Chuck in a three-jaw chuck
L - 8	Facing in a lathe
L - 28	Cutting a taper with a compound rest
S - 1	Cut to length on a horizontal band or a power hack saw
L/O - 9	Use a center punch
D - 1	Drill on a drill press
D - 2	Ream on a drill press
L - 7	Chucking in a four-jaw chuck
L - 10	Center drilling a lathe
L - 11	Drilling in a lathe
L - 24	Tapping in a lathe
L - 12	Reaming in a lathe
B - 3	Use allen wrenches


10-32 NF
10-32 NF
3/8
15/16
7/16
1/4 DIA.
.125 REAM 5/8 DEEP
①
30°
.250 REAM
1-3/4
1/2
BODY
②
.125 DIA.
60°
1-3/8
POINTS
③
.250 DIA.
12
BEAM

TOLERANCES: +- 1/32 · +-1°

4	4	10-32 X 3/16 ALLEN HD. SET SCREWS	
3	1	COLD ROLLED ROUND 1/4 DIA. X 13	
2	2	DRILL ROD 1/8 DIA. X 1-1/2	
1	2	COLD ROLLED SQUARE 1/2 X 1/2 X 2	
NO.	REQ	NAME AND OR SIZE	MAT.

SCALE FULL	REVISIONS	BY	DATE
DATE			
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AP'VD			

TITLE
STEEL BEAM TRAMMEL

NO.
196 14

STEEL BEAM TRAMMEL

PROJECT #14

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCEDURES: **BEAM**

1. Check stock diameter
    a. Use a vernier caliper
2. Layout the length
    a. Use a steel rule
    b. Layout blue
    c. Scriber
3. Cut to length
    a. Use a hand hacksaw
4. File all edges

POINTS

5. Check stock size
    a. Use vernier caliper
6. Layout the length
    a. Use a steel rule
    b. Layout blue
    c. Scriber
    d. Allow 1/8" for lathe work
7. Chuck in lathe
    a. Use a three-jaw chuck
8. Face the work both ends
    a. Face to length

9. Cut the angle
    a. Use a compound rest
10. Case harden

BODY

11. Check stock size
    a. Use a steel rule
12. Layout length
13. Cut to length
    a. Allow ¼" for facing in a lathe
    b. Use a band saw
14. Layout the length
    a. Layout one square line
    b. Layout the length
        (1) Place second square line
15. Layout the holes on the sides
    a. From the square lines
    b. Center punch
16. Drill and ream the .250" diameter hole
17. Chuck stock in a lathe
    a. Use a four-jaw chuck
    b. True the stock in the lathe
    c. Chuck the stock with the reamed hole out
18. Face the stock to the layout line
19. Center drill and tap the hole into the reamed hole
20. Reverse the end
21. Face to the second layout line
    a. Face to length

22. Center drill, drill and ream

23. Cut the angle

    a. Use the compound rest

24. Remove from lathe

25. Drill and tap the hole in the side

26. Chamfer all edges

27. Assemble the project

MACHINE SHOP

PROJECT #15

DISPLAY PROJECT

200

DISPLAY PROJECT

PROJECT #15

COURSES: Layout, Saws, Drill Presses, Bench Work

MATERIALS:

One Each - Plexiglass 1" x ½" x 3 3/4" Long

One Each - Plexiglass 1" x ¼" x 3 3/4" Long

One Each - 82° Flat Head Machine Screw ¼"-20 NC ½" Long

One Each - Allen Head Cap Screw ¼"-20 NC ½" Long

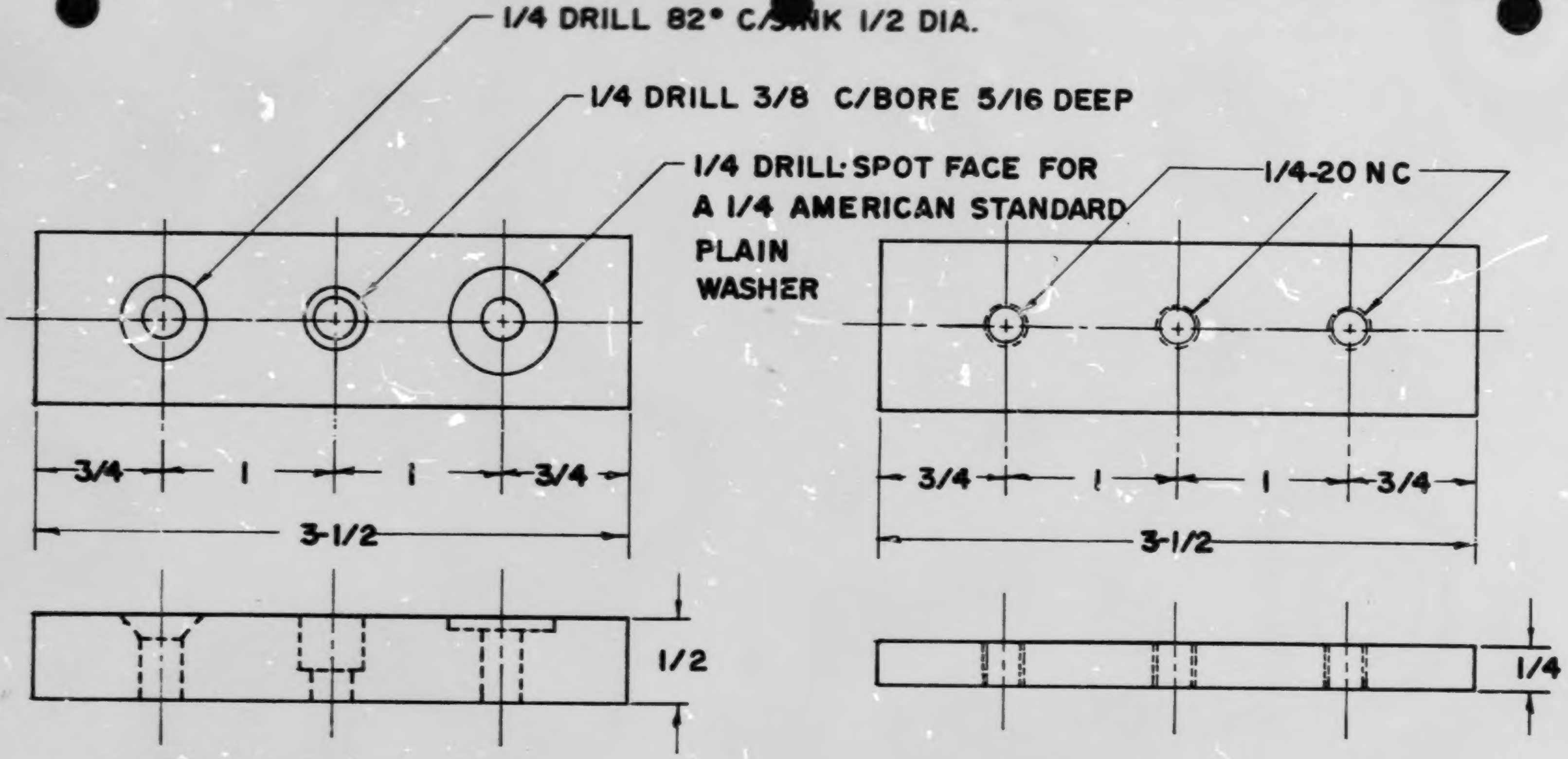
One Each - Round Head Cap Screw ¼'-20 NC 3/4" Long

One Each - American Standard Flat Washer ¼"

TASK:

L/O - 3	Use a combination set
L/O - 2	Use a scriber
S - 3	Cut an angle on a vertical band saw
D - 1	Drill on a drill press
D - 4	Countersink on a drill press
D - 5	Counterbore on a drill press
D - 6	Spot face on a drill press
D - 8	Center drill on a drill press
D - 7	Tapping on a drill press
B - 4	Use a screw driver
B - 3	Use allen wrenches

201


1/4 DRILL 82° C/SINK 1/2 DIA.
1/4 DRILL 3/8 C/BORE 5/16 DEEP
1/4 DRILL: SPOT FACE FOR A 1/4 AMERICAN STANDARD PLAIN WASHER
1/4-20 NC
3/4
1
1
3/4
3-1/2
1/2
3/4
1
1
3/4
3-1/2
1/4

⑥ HEAD PLATE

⑤ FASTENER PLATE

TOLERANCES: +-1/32 · +-1°

NO.	REQ.	NAME AND OR SIZE	MATERIAL
6	1	PLEXI GLASS 1" X 1/2" X 3-3/4"	
5	1	PLEXI GLASS 1" X 1/4" X 3-3/4"	
4	1	82° FLAT HEAD MACHINE SCREW 1/4-20NC x 1/2	
3	1	ALLEN HEAD CAP SCREW 1/4-20NC x 3/4	
2	1	ROUND HEAD MACHINE SCREW 1/4-20NC x 1/2	
1	1	AMERICAN STANDARD FLAT WASHER	

SCALE FULL	REVISIONS	BY	DATE
DATE			
DRN GWB	CKD		
AP VD			
TITLE DISPLAY PROJECTS		NO 203	

15

202

DISPLAY PROJECT

PROJECT #15

PROCEDURES: **HEAD PLATE**

1. Layout all dimensions
    a. Use a combination square
    b. Use a scriber
2. Cut to size
    a. Use a vertical band saw
3. Center drill, drill and countersink hole #1
4. Center drill, drill and counterbore hole #2
5. Center drill, drill and spot face hole #3
6. Polish all edges

FASTENER PLATE

1. Layout all dimensions
    a. Use a combination set
    b. Use a scriber
2. Cut to size
    a. Use a vertical band saw
3. Center drill, drill and tap all holes
4. Polish all edges
5. Assemble all parts

MACHINE SHOP

PROJECT #16

JACK STAND

JACK STAND

PROJECT #16

COURSES: Measuring, Layout Work, Bench Work, Saws, Drill Presses, Lathe

MATERIALS: One Each - Black Iron Pipe 2" x 3¼" Long

One Each - Black Iron Pipe 1½" x 12¼" Long

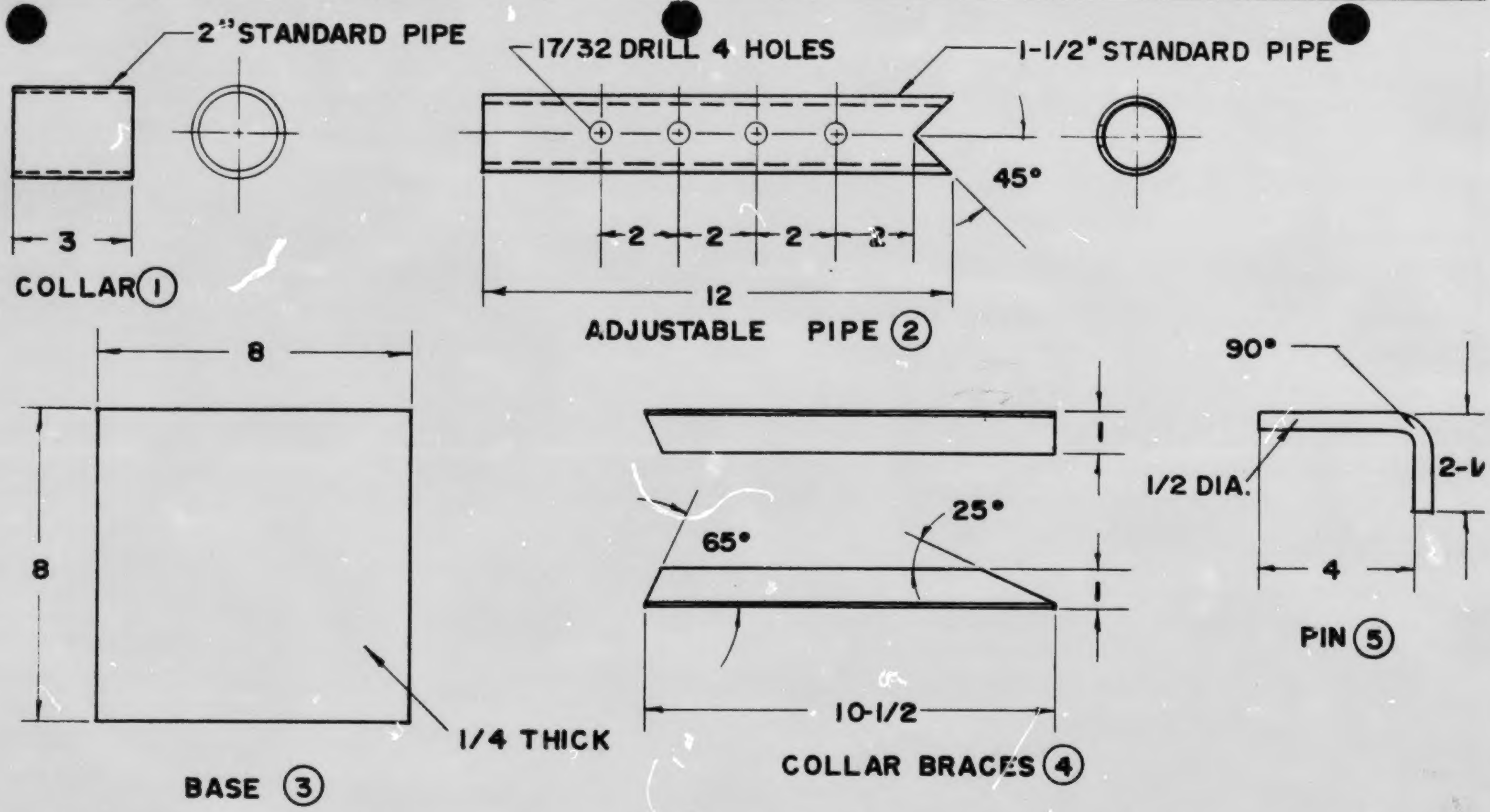
One Each - Hot Rolled Steel Plate ¼" x 8¼" x 8¼"

Four Each - Hot Rolled Steel Angle 1/8" x 1" x 1"

One Each - Hot Rolled Steel Round ½" diameter x 7" Long

TASK:

M - 16	Measuring with an inside caliper
S - 1	Cut to length on a horizontal band or power hacksaw
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 33	Using a steady rest on a lathe
L/O - 12	Use a solid keyseat rule
L/O - 3	Use a combination set
S - 3	Cut an angle on a vertical band saw
D - 1	Drilling on a drill press
L/O - 8	Use a prick punch
M - 7	Measuring with a steel tape
S - 2	Cut an angle on a horizontal band saw
B - 1	Use a bench vice
B - 2	Use a ball peen hammer


2" STANDARD PIPE
3
COLLAR ①
17/32 DRILL 4 HOLES
1-1/2" STANDARD PIPE
45°
2
2
2
2
12
ADJUSTABLE PIPE ②
8
8
1/4 THICK
BASE ③
1
65°
25°
1
10-1/2
COLLAR BRACES ④
90°
1/2 DIA.
2-1/
4
PIN ⑤

TOLERANCES: +- 1/32 +-1°

NO.	REQ	NAME AND OR SIZE	MAT.
5	1	BLACK IRON PIN 1/2 DIA. X 7	
4	4	ANGLE 1/8 X 1 X 1	HRS
3	1	PLATE 1/4 X 8-1/4 X 8-1/4	HRS
2	1	BLACK IRON PIPE 1-1/2 X 12-1/4	
1	1	BLACK IRON PIPE 2 X 3-1/4	

SCALE 1/4 SIZE		REVISIONS	BY	DATE
DATE				
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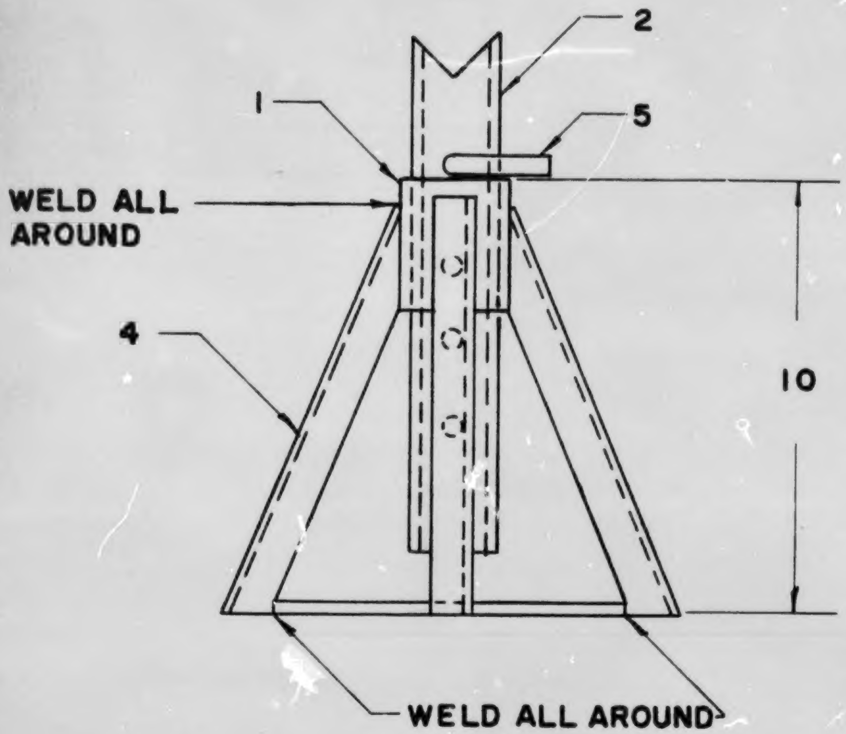
TITLE JACK STAND

NO 16

SHEET 1 OF 2

BRUNING 40-105


2
1
5
WELD ALL AROUND
4
10
WELD ALL AROUND

SCALE 1/4 SIZE
DATE
DR'N GWB
CKD
AP'VD

REVISIONS	BY	DATE

TITLE
JACK STAND ASSEMBLY

NO. 16
SHE[illegible] 2 OF 2

JACK STAND

PROJECT #16

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCUEDURES: **COLLAR**

1. Check the pipe size
   a. Use an inside caliper
2. Cut to length
   a. Use horizontal band saw
   b. Allow ¼" for facing in a lathe
3. Chuck in a lathe
   a. Use a three-jaw chuck
4. Face both ends
   a. Face to length
   b. Chamfer all edges

ADJUSTABLE PIPE

5. Cut to length
   a. Use a horizontal band saw
   b. Allow ¼" for facing in a lathe
6. Chuck in a lathe
   a. Use a three-jaw chuck
   b. Use steady rest
7. Face both ends
   a. Face to length
8. Remove from lathe

9. Scribe a center line
    a. Use a keyseat rule
10. Layout the angle
    a. Use a combination set
    b. The bottom of the angle on the center line
11. Layout the hole locations
    a. Layout on the center line
12. Cut the angle
    a. Use a vertical band saw
13. Drill the holes
    a. Drill all holes through both sides

BASE

14. Layout all sides
    a. Use a combination set
    b. Prick punch all lines
15. Cut to lines
    a. Use a vertical band saw
    b. Cut half the prick punch marks

COLLAR BRACES

16. Cut all braces to length
    a. Use a steel tape
17. Cut angles
    a. Use a horizontal band saw
    b. Set vice to angles shown
    c. Cut one end
    d. Setup and cut second end

PIN

211

18. Measure 2" from one end

    a. Mark with soap stone

19. Mount in bench vice
    a. 2" out of the vice
20. Heat with a torch
21. Bend by using a ball-peen hammer
22. Cut to length

ASSEMBLE

23. Chamfer all edges
24. Weld angle to base and collar
25. Paint

212

MACHINE SHOP

PROJECT #17

GEAR PULLER

GEAR PULLER

PROJECT #17

COURSES: Measuring, Bench Work, Layout, Saws, Drill Presses, Lathe

MATERIALS:

One Each - Cold Rolled Steel Square 7/8" x 7/8" x 5 3/16" Long

Two Each - Cold Rolled Steel Flat ¼" x 1" x 6 1/8" Long

One Each - Cold Rolled Steel Round ½" diameter x 9 5/8" Long

One Each - Cold Rolled Steel Round 3/4" diameter x 3 5/8" Long

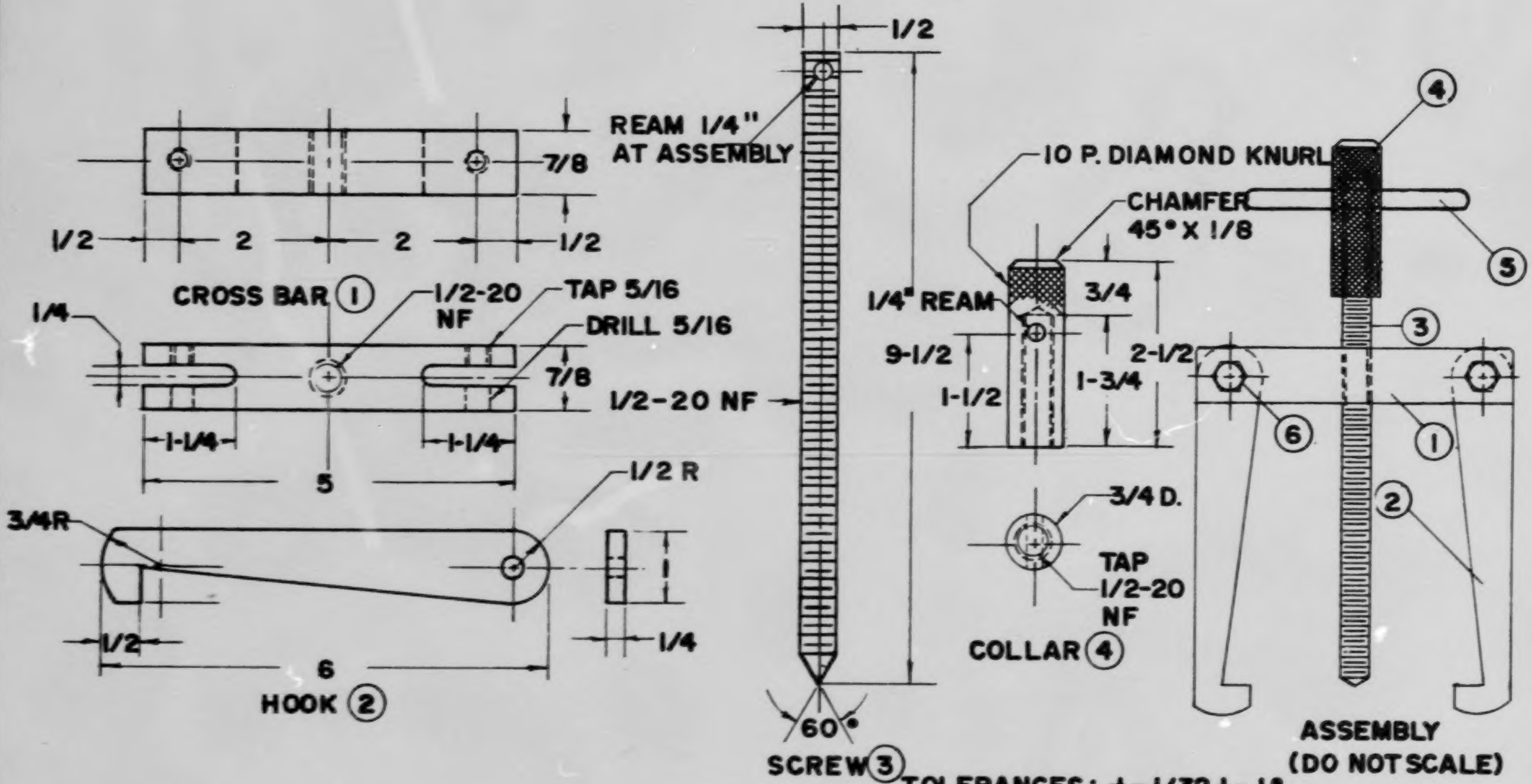
Two Each - Screws 5/16" - 18 NC - 1" Hex Head Machine

One Each - Roll Pin ¼" x 3" Long

TASK:

M - 34	Measuring with a vernier caliper
S - 1	Cutting to length on a horizontal band or power hacksaw
L/0 - 3	Using a combination set
L/0 - 5	Using layout blue
L/0 - 2	Using a scriber
L/0 - 6	Using a divider
L/0 - 1	Using layout tables
S - 3	Cutting an angle on a vertical band saw
S - 6	Cutting a radius on a vertical band saw
D - 1	Drilling on a drill press
B - 13	Use an electric hand drill
S - 4	Cutting an internal surface on the vertical band saw
B - 6	Use a file
D - 7	Tapping on a drill press
M - 30	Measuring with an outside micrometer caliper
L - 6	Chucking in a three-jaw chuck

L - 8	Facing in a lathe
L- 28	Cutting a taper with a compound rest
B - 8	Use a die
L - 10	Center drilling in a lathe
L - 15	Knurling on a lathe
L - 11	Drilling in a lathe
L - 24	Tapping in a lathe


REAM 1/4" AT ASSEMBLY
1/2
7/8
1/2
2
2
1/2
CROSS BAR ①
1/4
1/2-20 NF
TAP 5/16
DRILL 5/16
7/8
1/2-20 NF
1-1/4
1-1/4
5
1/2 R
3/4R
1
1/2
1/4
6
HOOK ②
60°
SCREW ③
9-1/2
10 P. DIAMOND KNURL
CHAMFER 45° X 1/8
1/4" REAM
3/4
1-1/2
1-3/4
2-1/2
3/4 D.
TAP 1/2-20 NF
COLLAR ④
④
⑤
③
⑥
①
②
ASSEMBLY (DO NOT SCALE)

TOLERANCES: +-1/32 +-1°

NO.	REQ.	NAME AND OR SIZE	MAT.
6	2	5/16-18 X 1" HEX HD. MACHINE SCREW	
5	1	1/4 DIA. X 3 ROLL PIN	CRS
4	1	3/4 DIA. X 3-5/8 COLLAR	CRS
3	1	1/2 DIA. X 9-5/8 SCREW	CRS
2	1	1/4 X 1 X 6 1/8 HOOK	CRS
1	1	7/8 X 7/8 X 5-3/16 CROSSBAR	CRS

SCALE 1/2 SIZE		REVISIONS	BY	DATE
DATE				
DR'N GWB	CKD			
AP'VD				

TITLE GEAR PULLER

NO 217

17

59

BRUNING 40-105

216

GEAR PULLER

PROJECT #17

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCEDURES: **HOOKS** - Two required

1. Check stock size
    a. Use a vernier caliper
2. Cut to length
    a. Use a horizontal band or power hacksaw
3. Layout all dimension
    a. Use a combination set
    b. Coat with layout blue
    c. Use a scriber
    d. Use a divider
    e. Use a layout table
4. Cut the angles
    a. Use a vertical band saw
5. Cut the radii
    a. Use a vertical band saw
    b. Smooth with a file (a belt sander if available)
6. Drill the holes
    a. Use a drill press
7. Remove the layout blue and chamfer

CROSS BAR

8. Check the stock size
9. Layout all dimensions

    a. Cut and file to length

10. Drill a ¼" hole for the slot

 a. Drill with a hand drill

11. Cut the slot

    a. Use a vertical band saw

    b. File the slot

12. Drill and tap all holes

    a. Use a drill press

13. Chamfer all edges

SCREW

14. Check stock size

    a. Use an outside micrometer caliper

15. Cut to length

    a. Allow ¼" for facing

16. Chuck in a lathe

    a. Use a three-jaw chuck

17. Face to length

18. Cut the angle

    a. Use the compound rest

19. Remove from lathe

20. Thread the rod

    a. Jam nuts may be used to prevent damaging the precut threads

21. Chamfer all edges

COLLAR

22. Check stock size

23. Cut stock to 3 5/8" long

24. Chuck in a lathe

    a. Chuck in a three-jaw chuck

25. Face one end

26. Center drill

27. Insert Center

28. Knurl

29. Remove Center

30. Drill and tap

31. Chamfer

32. Cut to length
    a. Use a horizontal band saw
    b. Allow 1/8" for facing

33. Chuck in a lathe
    a. Use false jaws

34. Face to length

35. Chamfer

ASSEMBLY

36. Screw collar on screw

37. Drill and ream

38. Insert roll pin

39. Mount cross bar and hooks

40. Screw T-handle assembly into cross bar

MACHINE SHOP

PROJECT # 18

TOOL POST BASE

TOOL POST BASE

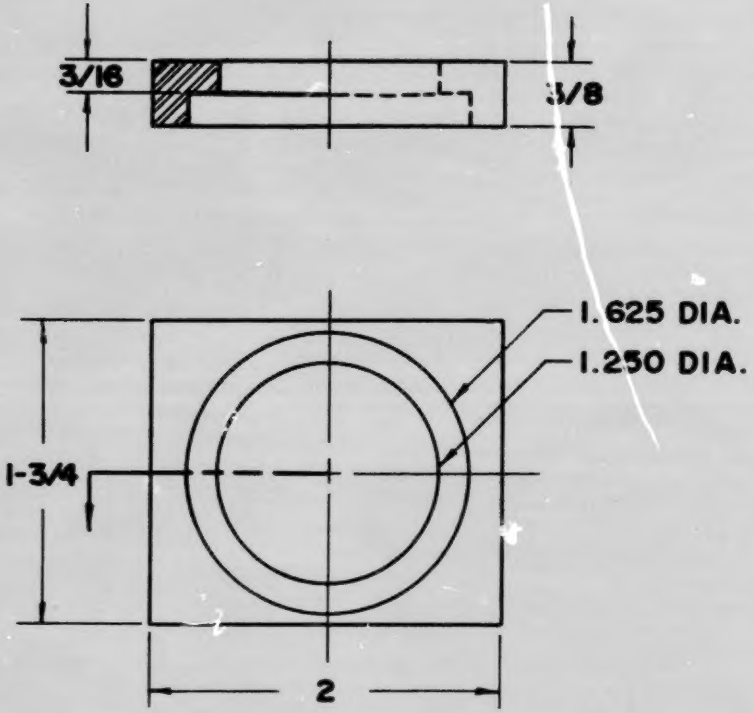
PROJECT #18

COURSES: Measuring, Layout, Bench Work, Saws, Drill Presses

MATERIALS: One Each - Cold Rolled Steel Flat 3/8" x 1 3/4" x 2"

TASK:

M - 34	Measuring with a vernier caliper
S - 1	Cutting to length with a horizontal band or a power hacksaw
M - 1	Measuring with a steel rule
B - 6	Using a file
L/O - 5	Using layout blue
L/O - 2	Using a scriber
M - 4	Using a rule as a straight edge
D - 8	Center drilling on a drill press
D - 1	Drilling on a drill press
D - 3	Boring on a drill press
M - 17	Measuring with an inside caliper using a micrometer
M - 30	Using an outside micrometer caliper


3/16
3/8
1.625 DIA.
1.250 DIA.
1-3/4
2

TOLERANCES: +- 1/32· +-.005

MATERIAL: COLD ROLLED STEEL PLATE 3/8 X 1-3/4 X 2

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AP'VD.			

TITLE

TOOL POST BASE

NO 224

223

18

BRUNING 40-105

TOOL POST BASE

PROJECT #18

PROCEDURES:

1. Check stock size
    a. Use vernier caliper
2. Cut and file to length
    a. Use horizontal band saw
    b. Use steel rule
    c. Use a file
3. Locate center
    a. Use a steel rule as a straight edge
4. Set up in drill press
    a. Use a vice
    b. Use parallel
    c. Use the tailstock center to locate the center of the stock
5. Center drill center
6. Pilot drill
7. Drill the 1¼" hole
8. Bore the 1.625 hole
    a. Use inside calipers and micrometer
9. Chamfer all edges

REFERENCES

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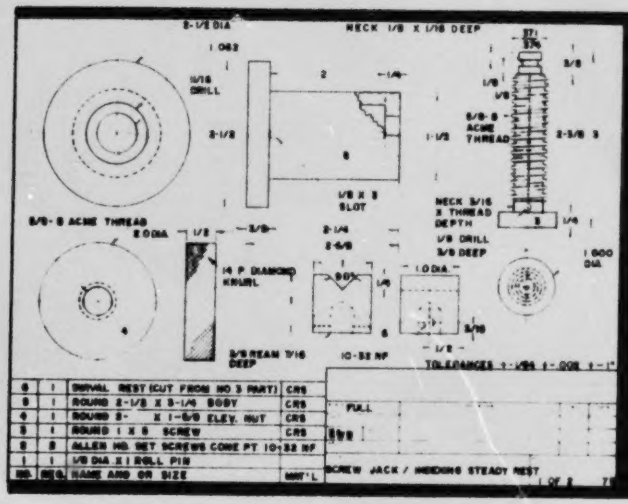
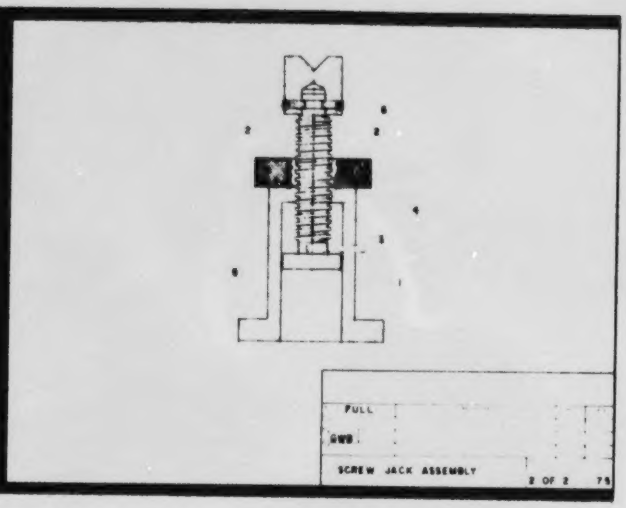
2. Lascoe, Nelson, Porter: Machine Shop - Operations and Setups. Chicago: American Technical Society, 1973
3. Oberg, Erik and Jones, F. D.: Machinery's Handbook. New York, N.Y.: Industrial Press Inc., 1976
4. Morse: Machinist's Practical Guide. New Bedford, Mass: Morse Cutting Tools Division, 1978
5. Krar, S.F.; Oswald, J. W. and St. Amond, J. E.: Technology of Machine Tools. New York: McGraw-Hill Book Company, Gregg Division, 1977

MACHINE SHOP PROJECTS

MEASURING, LAYOUT, GRINDER, LATHE
Projects 19-30


NECK 1/8 X 1/16 DEEP
5/8-8 ACME THREAD
14 P DIAMOND KNURL
3/8 REAM 7/16 DEEP
10-32 NF
TOLERANCES
FULL
SCREW JACK / MEHDING STEADY REST
1 OF 2


FULL
SCREW JACK ASSEMBLY
2 OF 2

STUDENT MANUAL

Georgia Department of Education

MACHINE SHOP PROJECTS

Developed Under a Grant from

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1980

This project was developed under a grant from:

Division of Program Development
Office of Vocational Education
Georgia Department of Education

Project Numbers: 98251 and 28252

to:

Augusta Area Vocational-Technical School

Author:
Raymond E. Westbrook
Instructor, Machine Shop

Drawings:
George W. Baggs, Jr.
Instructor, Drafting and Design

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TABLE OF CONTENTS

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Part A: PURPOSE

Part B: PROJECT LISTING (Categorized)

Part C: PROJECTS - 1-101:

- Cover Sheet
- Information Sheet
- Project Drawings
- Fabrication Procedures

Part D: REFERENCES

PURPOSE

A student in Machine Shop must learn by doing. Although lectures, reading assignments, and audio-visual aids are very necessary, these methods alone will never produce a good machinist. The combination of both classroom and shop practice is essential to your training. The purpose of this Shop Project Guide is to give the necessary shop experience to complement your classroom training. This guide is based on the author's years of practical experience as a skilled machinist and as a teacher in the field. Each skill needed to complete a phase of your training has been identified. Next, projects have been devised to give hands-on experience for each skill with enough repetition so that you will become capable of using each tool or attachment for the particular machine or operation being taught. Your instructor will help you select or will assign the projects in the necessary order. You will also find the end products of these projects will be useful tools that will help in your training that follows. This serves not only to make the projects more interesting, but more enjoyable to construct. This practical training along with classroom instruction and applied learning can bring you a rewarding future as a skilled tradesman.

PROJECT LISTING (CATEGORIZED)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench
*11. Pipe flange assembly
*12. C-clamp
*13. Block and tackle
*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects
*16. Jack Stand
*17, Gear puller
18. Tool post base

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MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (genreal purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. 1/4" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
[illegible]0. Dead center
41. Plumb bob

42. Dumbbell set

43. Taper plug gage

44. Rocker dish

45. Rocker

46. Tool post body

47. Circle cutter

48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II

*50. Fly cutter

51. Tooth pick holder

*52. Pipe center

53. Taper ring gage

54. Set up bolt 1/2" x 4"

55. Set up bolt 1/2" x 6"

56. Set up bolt 1/2" x 8"

57. Set up bolt 3/8" x 4"

58. Set up bolt 3/8" x 6"

59. Drill reducer

60. Tap drill extension (1/4" - 20 NC tap drill)

61. Tap drill extension (5/16" - 18 NC tap drill)

62. Boring bar holder body jig

63. Boring bar holder body

*64. Boring bar holder base

65. Boring bar holder inner body

66. Boring bar holder base jig

67. Precision measuring tool block

*68. Milling arbor #40 - 3/8"

*69. Milling arbor #40 - 1/5"

*70. Milling arbor #40 - 5/8"

*71. Milling arbor #40 - 3/4"

*72. Lathe arbor

73. Mallet

74. Acme thread/boring tool

*75. Screw jack/indexing steady rest

76. Lathe chuck wrench

77. Internal pipe wrench

78. Buffer/grinder shaft

SHAPER

79. Splitting wedge

80. Flat strap clamp

*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks I

*83. V-blocks

84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge

86. Solid key seat

87. Water valve wrench

88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. 1/4" pitch, 1' lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

MACHINE SHOP

PROJECT #19

RIGHT HAND TOOL (GENERAL PURPOSE)

237

RIGHT HAND TOOL (GENERAL PURPOSE)

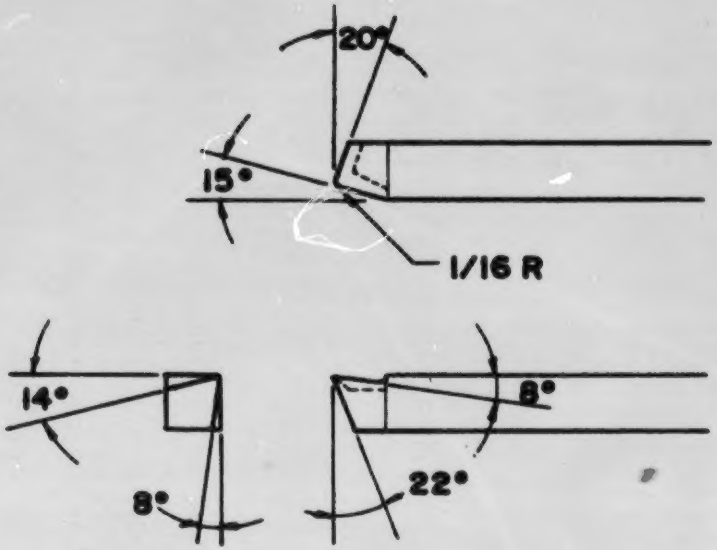
PROJECT #19

COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

TASK:

L - 1	Grind a general purpose lathe tool
M - 30	Measuring with an outside micrometer caliper
G - 1	Dressing the wheel for grinding
L/O - 3	Use a combination set
G - 2	Off-hand grinding
M - 18	Measuring with a radius and fillet gage



MATERIAL: 5/16 X 5/16 HIGH SPEED STEEL TOOL BLANK

TOLERANCES: +-2°

SCALE FULL	REVISIONS	BY	DATE
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TITLE RIGHT HAND TOOL GENERAL PURPOSE	NO. 240		

19

239

RIGHT HAND TOOL (GENERAL PURPOSE)

PROJECT #19

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock.

Two angles should be ground at a time.

PROCEDURES:

1. Check the tool size
    a. Use an outside micrometer
2. Dress the grinding wheel
3. Layout the 15° side cutting edge on the left side of the blank
    a. Use a combination set
    b. Use a pencil
    c. The length is the same as the square of the tool blank
4. Set the protractor at 8° off 90°
    a. Side clearance or relief
5. Place the tool on the protractor
    a. Note the space
6. Rest the tool on your finger
7. Line the pencil mark to the face of the wheel
8. Tilt the tool to the previously noted space
9. Grind the two angles
    a. Push straight in while moving across the face of the wheel
    b. Do not roll the tool or change the angles
10. Layout the end cutting edge angle 20°
    a. Use a protractor

    b. Use a pencil

11. Set the protractor for 22° off 90°

    a. End clearance angle

12. Place the tool on the protractor

    a. Note the space

13. Rest the tool on your finger

14. Line the pencil mark to the face of the wheel

15. Tilt the tool to the previously noted space

16. Grind the two angles

17. Layout the 8° back rake

    a. Use a protractor

    b. Use a pencil

18. Set the protractor at 14° off 0°

    a. Side rake angle

19. Place the tool on your finger

    a. Note the space

20. Rest the tool on your finger

21. Line the pencil mark to the face of the wheel

22. Tilt the tool to the previously noted space

23. Grind the two angles

24. Grind the nose radius

    a. Be certain to grind the same from the top and bottom

    b. A honing stone may be used until more experience is gained on the grinder

    c. Check radius with a radius and fillet gage

25. Hone all edges slightly

24?

MACHINE SHOP

PROJECT #20

LEFT HAND TOOL (GENERAL PURPOSE)

LEFT HAND TOOL (GENERAL PURPOSE)

PROJECT #20

COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

TASK:

L - 1 Grind a general purpose lathe tool

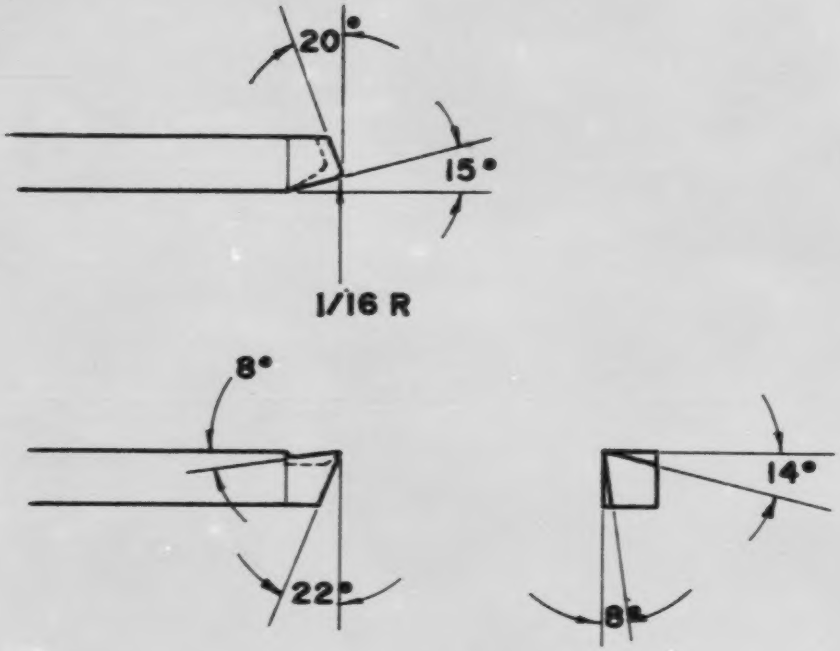
M - 30 Measure with an outside micrometer caliper

G - 1 Dressing the wheel for grinding

L/O - 3 Use a combination set

G - 2 Off-hand grinding

M - 18 Measure with a radius and fillet gage


20°
15°
1/16 R
8°
22°
14°
8°

MATERIAL: 1, 5/16 X 5/16 HIGH SPEED TOOL BIT

TOLERANCE: +-2°

245

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DR'N GWB CK'D			
AP'VD			

TITLE
LEFT HAND TOOL
(GENERAL PURPOSE)

NO. 246

LEFT HAND TOOL (GENERAL PURPOSE)

PROJECT #20

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock.

Two angles should be ground at a time.

PROCEDURES:

1. Check the tool size
   a. Use an outside micrometer
2. Dress the grinding wheel
3. Layout the 15° side cutting edge on the right side of the tool blank
   a. Use a combination set
   b. Use a pencil
   c. The length is the same as the square of the tool blank
4. Set the protractor 8° off 90°
   a. Side clearance or relief
5. Place the tool on the protractor
   a. Note the space
6. Rest the tool on your finger
7. Line the pencil mark to the face of the wheel
8. Tilt the tool to the previously noted space
9. Grind the two angles
   a. Push straight in while moving across the face of the wheel
   b. Do not roll the tool or change the angle

10. Layout the end cutting edge angle 20°
    a. Use a protractor
    b. Use a pencil
11. Set the protractor for 22° off 90°
    a. End clearance angle
12. Place the tool on the protractor
    a. Note the space
13. Rest the tool on your finger
14. Line the pencil mark to the face of the wheel
15. Tilt the tool to the previously noted space
16. Grind the two angles
17. Layout the 8° back rake
    a. Use a protractor
    b. Use a pencil
18. Set the protractor at 14° off 0°
    a. Side rake angle
19. Place the tool on the protractor
    a. Note the space
20. Rest the tool on your finger
21. Line the pencil mark to the face of the wheel
22. Tilt the tool to the previously noted space
23. Grind the two angles
24. Grind the nose radius
    a. Be certain to grind the same from the top and bottom
    b. A honing stone may be used until more experience is gained on the grinder
    c. Check radius using a radius gage
25. Hone all edges slightly

MACHINE SHOP

PROJECT #21

LEFT HAND ROUGHING TOOL

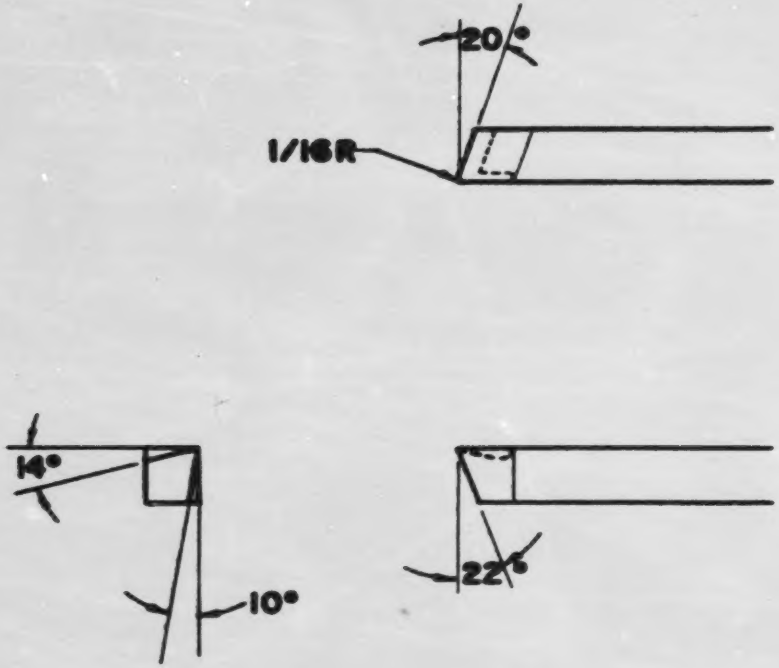
LEFT HAND ROUGHING TOOL

PROJECT #21

COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" square

TASK:	L - 2	Grinding a roughing lathe tool
	M - 30	Measuring with an outside micormeter caliper
	G - 1	Dressing the wheel for grinding
	L/O - 3	Use a combination set
	G - 2	Off-hand grinding
	M - 18	Measuring with a radius and fillet gage



MATERIAL: 5/16 X 5/16 HIGH SPEED TOOL BIT

TOLERANCE: +-2°

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AP'VD.			

TITLE RIGHT HAND TOOL
ROUGHING

NO. 252 21

251

LEFT HAND ROUGHING TOOL

PROJECT #21

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock.

PROCEDURES:

1. Check the size
   a. Use an outside micrometer
2. Dress the grinding wheel
3. Set the protractor at 10° off 90°
   a. Side clearance angle
4. Place the right side of the tool against the protractor rule
   a. Note the space
5. Rest the tool on your finger
6. Line the right side of the tool to the face of the wheel
   a. The length to be ground is the square of the tool
7. Tilt the tool to the previously noted space
8. Grind the angle
   a. Push straight in on the tool
   b. Do not roll the tool or change the angle
9. Layout the end cutting edge angle 20°
   a. Use the protractor of a combination set
   b. Use a pencil
10. Set the protractor for 22° off 90°
    a. End clearance angle

11. Place the tool on the protractor
    a. Note the space
12. Rest the tool on your finger
13. Line the pencil mark to the face of the wheel
14. Tilt the tool to the previously noted space
15. Grind the two angles
    a. End clearance and end cutting edge
16. Set the protractor at 14° off 0°
    a. Side rake angle
17. Place the tool on the protractor
    a. Note the space
18. Rest the tool on your finger
19. Tilt the tool to the previously noted space
20. Grind the angle
21. Grind the nose radius
    a. Be certain to grind the same from the top and bottom
    b. A honing stone may be used until more experience is gained on the grinder
    c. Check radius with a radius gage
22. Hone all edges slightly

MACHINE SHOP

PROJECT #22

RIGHT HAND ROUGHING TOOL

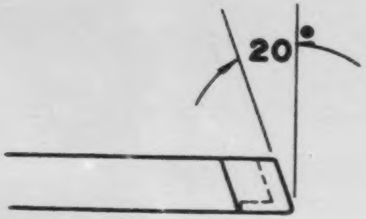
RIGHT HAND ROUGHING TOOL

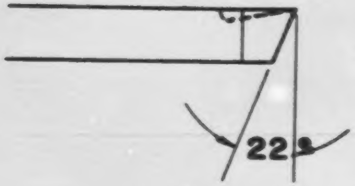
PROJECT #22

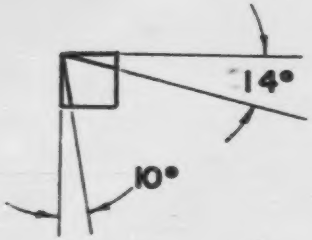
COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

TASK:	L - 2	Grinding a roughing lathe tool
	M - 30	Measuring with an outside micrometer caliper
	G - 1	Dressing the wheel for grinding
	L/O - 3	Using a combination set
	G - 2	Off-hand grinding
	M - 18	Measuring with a radius and fillet gage







MATERIAL: 1, 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT. TOLERANCE: +− 2°

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AP'VD.			

TITLE
LEFT HAND TOOL
ROUGHING

NO.
258

257

RIGHT HAND ROUGHING TOOL

PROJECT #22

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock.

PROCEDURES:

1. Check the size
    a. Use an outside caliper
2. Dress the grinding wheel
3. Set the protractor at 10° off 90°
    a. Side clearance angle
4. Place the right side of the tool against the protractor rule
    a. Note the space
5. Rest the tool on your finger
6. Line the left side of the tool to the face of the wheel
    a. The length to be ground is the square of the tool
7. Tilt the tool to the previously noted space
8. Grind the angle
    a. Push straight in on the tool
    b. Do not roll the tool or change the angle
9. Layout the end cutting edge angle 20°
    a. Use the protractor of a combination set
    b. Use a pencil
10. Set the protractor for 22° off 90°
    a. End clearance angle
11. Place the tool on the protractor
    a. Note the space

12. Rest the tool on your finger

13. Line the pencil mark to the face of the wheel

14. Tilt the tool to the previously noted space

15. Grind the two angles

    a. End clearance and end cutting edge

16. Set the protractor at 14° off 0°

    a. Side rake angle

17. Place the tool on the protractor

    a. Note the space

18. Rest the tool on your finger

19. Tilt the tool to the previously noted space

20. Grind the angle

21. Grind the nose radius

    a. Be certain to grind the same from the top and bottom

    b. A honing stone may be used until more experience is gained on the grinder

    c. Check radius with a radius gage

22. Hone all edges slightly

MACHINE SHOP

PROJECT #23

LEFT HAND TOOL (TURNING OR FINISHING)

261

LEFT HAND TOOL (TURNING OR FINISHING)

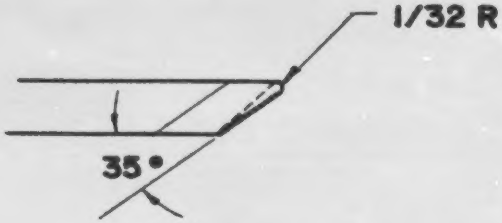
PROJECT #23

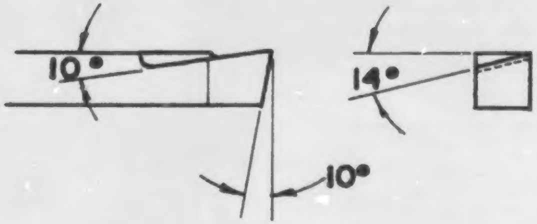
COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

TASK:

L - 3	Grinding a turning tool
M - 30	Measuring with an outside micormeter caliper
G - 1	Dressing the wheel for grinding
L/O - 3	Using a combination set
G - 2	Off-hand grinding
M - 18	Measuring with a radius and fillet gage





MATERIAL: 1, 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT. TOLERANCE: +− 2°

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SCALE FULL
DATE
DR'N. GWB
CKD.
APVD.

REVISIONS	BY	DATE

TITLE LEFT HAND TOOL
(TURNING OR FINISHING)

NO. 264

BRUNING 40-105

LEFT HAND TOOL (TURNING OR FINISHING)

PROJECT #23

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock.

Review the procedures in Project #17 - 20.

PROCEDURES:

1. Check the tool size
    a. Use an outside micrometer
2. Dress the grinding wheel
3. Grind the cutting edge and clearance angle
    a. Use a combination set to check the angles
4. Grind the rake angles
5. Grind the radius
    a. Check with a radius gage
6. Hone all edges slightly

MACHINE SHOP

PROJECT #24

RIGHT HAND TOOL (TURNING OR FINISHING)

RIGHT HAND TOOL (TURNING OR FINISHING)

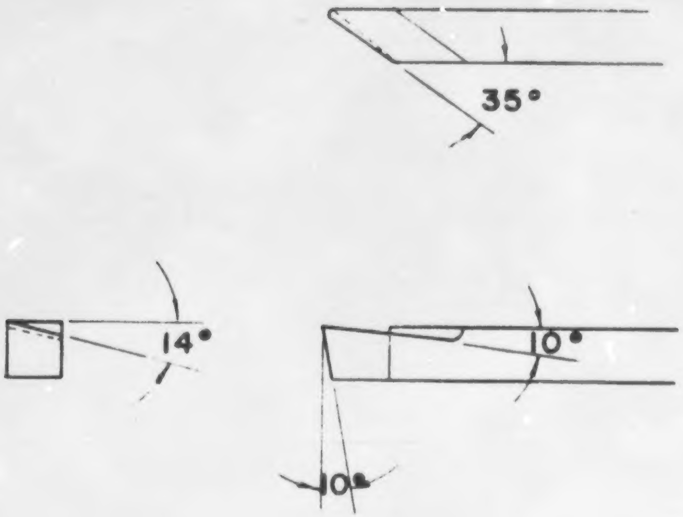
PROJECT #24

COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

TASK:

L - 3	Grinding a turning tool
M - 30	Measuring with an outside micrometer caliper
G - 1	Dressing the wheel for grinding
L/O - 3	Using a combination set
G - 2	Off-hand grinding
M - 18	Measuring with a radius and fillet gage



MATERIAL: 1, 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT

TOLERANCE: + - 2°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CK'D			
APP'D			
TITLE RIGHT HAND TOOL (TURNING OR FINISHING)	NO 269 24		

RIGHT HAND TOOL (TURNING OR FINISHING)

PROJECT #24

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock. Review the procedures in Project #17 - 20

PROCEDURES:

1. Check the tool size
    a. Use an outside micrometer
2. Dress the grinding wheel
3. Grind the cutting edge and clearance angle
    a. Use a combination set to check the angles
4. Grind the rake angles
5. Grind the radius
    a. Check with a radius gage
6. Hone all edges lightly

MACHINE SHOP

PROJECT #25

NECKING TOOL

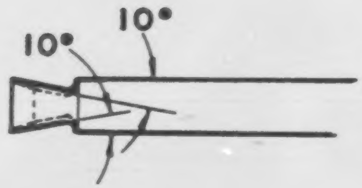
NECKING TOOL

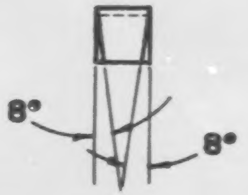
PROJECT #25

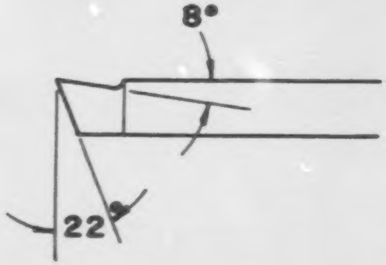
COURSES: Measuring, Layout work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

TASK:	L - 5	Grinding on necking tool
	M - 34	Measuring with a vernier caliper
	G - 1	Dressing the wheel for grinding
	L/O - 3	Use a combination set
	G - 2	Off-hand grinding







MATERIAL: 1, 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT.

TOLERANCE: + - 2°

SCALE FULL

DATE

DR'N GWB

CKD

AP'VD

REVISIONS	BY	DATE

TITLE NECKING TOOL

NO. 274

273

BRUNING 40-103

NECKING TOOL

PROJECT #25

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock. Review the procedures in Project #17 - 20.

PROCEDURES:

1. Check the tool size
   a. Use a vernier caliper
2. Dress the grinding wheel
3. Grind the end clearance
   a. Check with a combination set
      (1) Check 22° angle
      (2) Check squareness
4. Grind the side clearance angle 8° and side relief angle 10°
   a. Left side
   b. Right Side
   c. Check with a protractor
5. Grind the back rake angle 8°
   a. Check the angle with a combination set
6. Hone all angles slightly

275

MACHINE SHOP

PROJECT #26

LEFT HAND FACING TOOL

LEFT HAND FACING TOOL

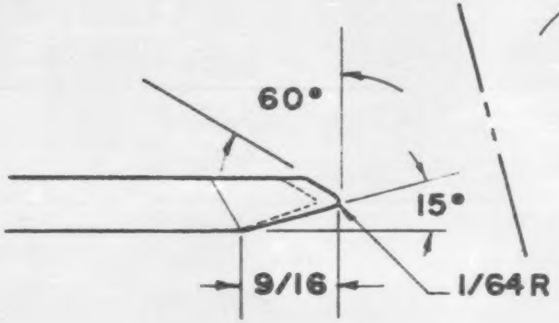
PROJECT #26

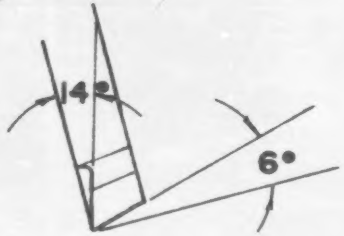
COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

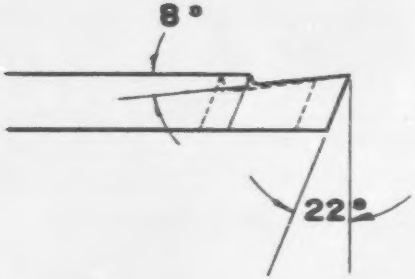
TASK:

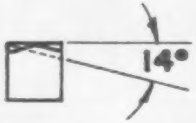
L - 4	Grind a facing tool
M - 34	Measuring with a vernier caliper
G - 1	Dressing the wheel for grinding
G - 2	Off-hand grinding
L/O - 3	Use a combination set
M - 18	Measure with a radius and fillet gage


60°
15°
9/16
1/64 R



AUXILIARY VIEW SHOWING
SIDE RELIEF AND SIDE RAKE





MATERIAL: 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT. TOLERANCE: +−2°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB / CKD.			
AP'VD.			

TITLE LEFT HAND FACING TOOL

NO. 26

LEFT HAND FACING TOOL

PROJECT #26

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock.
Review the procedures in Project #17 - 20

PROCEDURES:

1. Check the tool size
    a. Use a slide vernier
2. Dress the grinding wheel
3. Grind the side clearance 6° and the side cutting edge 15° to 9/16" long
    a. These two angles must be ground at the same grind
    b. Check with a combination set
4. Grind the end cutting edge 60° and the end clearance 22°
    a. These two angles must be ground at the same grind
    b. Check with a protractor
5. Grind the back rake 6° and the side rake 14°
    a. These two angles must be ground at the same grind
    b. Check the angles with a protractor
6. Grind the 1/64" nose radius
    a. Check with a radius gage
7. Hone all edges slightly

MACHINE SHOP

PROJECT #27

RIGHT HAND FACING TOOL

281

RIGHT HAND FACING TOOL

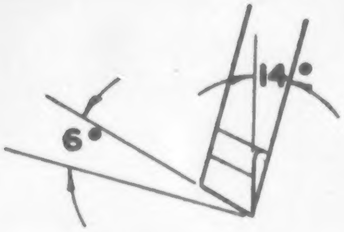
PROJECT #27

COURSES: Measuring, Layout Work, Lathe, Grinding

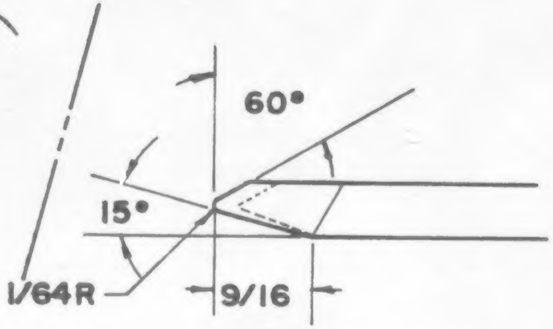
MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

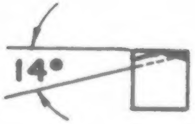
TASK:

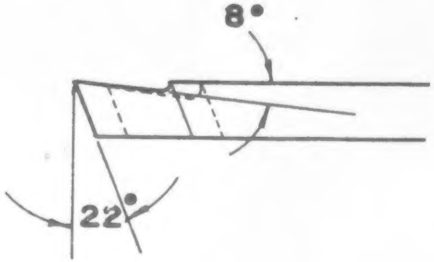
L - 4	Grinding a facing tool
M - 34	Measuring with a vernier caliper
G - 1	Dressing the wheel for grinding
G - 2	Off-hand grinding
L/O - 3	Use a combination set
M - 18	Measuring with a radius and fillet gage



AUXILIARY VIEW SHOWING SIDE RELIEF AND SIDE RAKE


60°
15°
1/64R
9/16





MATERIAL: 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT. TOLERANCE: + − 2°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			

283

TITLE RIGHT HAND FACING TOOL

NO. 284

27

RIGHT HAND FACING TOOL

PROJECT #27

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock.
Review the procedures in Project #17 - 20

PROCEDURES:

1. Check the tool size
    a. Use a slide vernier
2. Dress the grinding wheel
3. Grind the side clearance 6° and the side cutting edge 15° to 9/16" long
    a. These two angles must be ground at the same grind
    b. Check with a combination set
4. Grind the end cutting edge 60° and the end clearance 22° angles
    a. These two angles must be ground at the same grind
    b. Check with a protractor
5. Grind the back rake 6° and the side rake angle 14°
    a. These two angles must be ground at the same grind
    b. Check the angles with a protractor
6. Grind the 1/64" nose radius
    a. Check with a radius gage
7. Hone all edges slightly

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MACHINE SHOP

PROJECT #28

V-THREADING TOOL

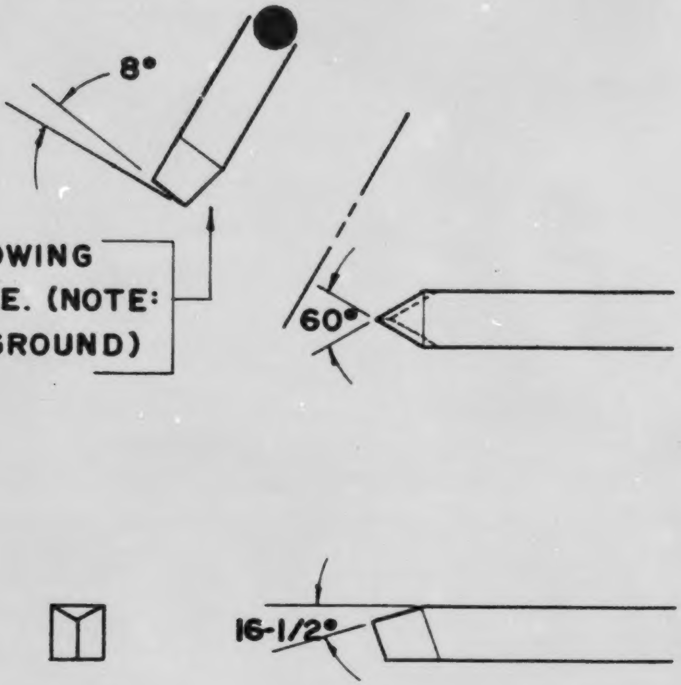
V-THREADING TOOL

PROJECT #28

COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

TASK:		
	L - 21	Grinding a threading tool
	M - 34	Measuring with a vernier caliper
	G - 1	Dressing the wheel for grinding
	G - 2	Off-hand grinding
	L/O - 3	Use a combination set
	M - 20	Use a center gage



AUXILIARY VIEW SHOWING
8° CLEARANCE ANGLE. (NOTE:
TWO SIDES TO BE GROUND)

MATERIAL: 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT. TOLERANCE: + - 2°

288

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB / CKD.			
AP'VD.			

TITLE V- THREADING TOOL

NO. 289

28

V-THREADING TOOL

PROJECT #28

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock. Review the procedure in Project #17 - 20.

PROCEDURES:

1. Check the tool blank size
   a. Use a vernier caliper
2. Dress the grinding wheel
3. Grind the 16½° negative rake angle
   a. Use a protractor to check the angle
4. Use a center gage to scribe the 60° included angle
5. Grind the side clearance angle 8° and the side cutting edge angle 30°
   a. These two angles must be ground at the same grind
   b. Check the angles with a protractor
6. Grind the same angle on the other side
7. Now the 60° included angle may be checked with a center gage
8. Hone all edges slightly

MACHINE SHOP

PROJECT #29

OFF-SET V-THREADING TOOL

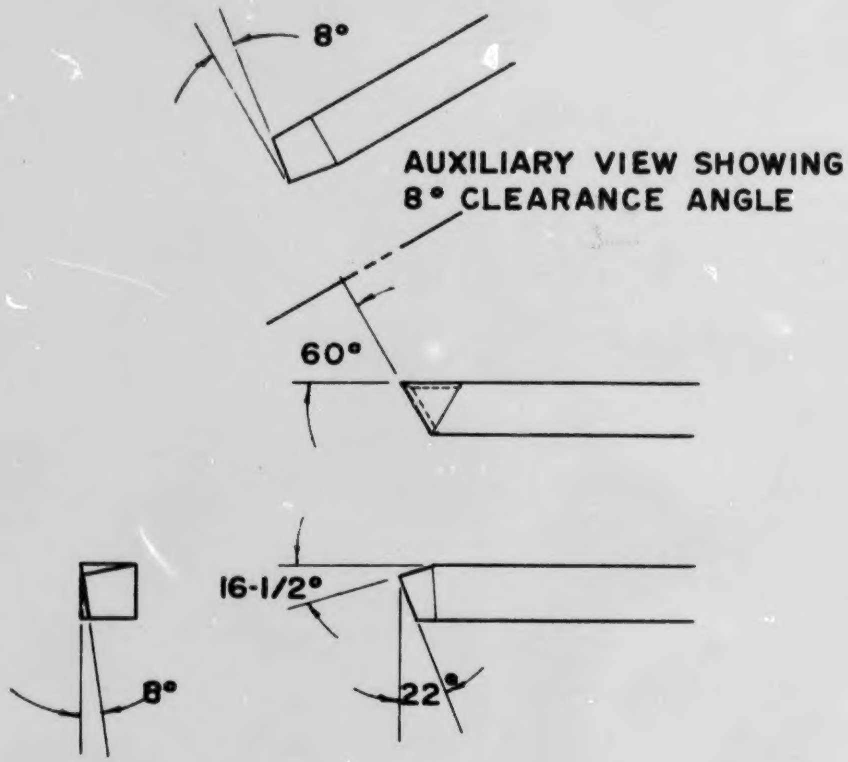
OFF-SET V-THREADING TOOL

PROJECT #29

COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

TASK:	L - 21	Grinding a threading tool
	M - 34	Measuring with a vernier caliper
	G - 1	Dressing the wheel for grinding
	G - 2	Off-hand grinding
	L/O - 3	Use a combination Set
	M - 20	Use a center gage


8°
AUXILIARY VIEW SHOWING
8° CLEARANCE ANGLE
60°
16-1/2°
8°
22°

MATERIAL: 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT. **TOLERANCE:** + − 2°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD			
AP'VD			

TITLE

OFFSET V-THREADING TOOL

NO 294 29

293

BRUNING 40-105

OFF-SET V-THREADING TOOL

PROJECT #29

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock. Review the procedures on Project #17 - 20.

PROCEDURES:

1. Check the tool blank size
    a. Use a vernier caliper
2. Dress the grinding wheel
3. Grind the $16\frac{1}{2}^{\circ}$ negative rake angle
    a. Slope the angle to the right corner
    b. Check with a protractor
4. Use a center gage to scribe the 60° included angle
    a. Hook one end over the right edge
        (1) This edge will be the right cutting edge
        (2) Mark the left cutting edge with a pencil
5. Grind the side clearance angle 8° and the side cutting edge angle on the left side of the tool blank
    a. These two angles must be ground at the same grind
    b. Check the angles with a protractor and center gage
6. Grind the side clearance
    a. Care must be taken not to change the 60° included angle
    b. Check the included angle with a center gage
7. Hone all edges slightly

MACHINE SHOP

PROJECT #30

ACME THREADING TOOL

ACME THREADING TOOL

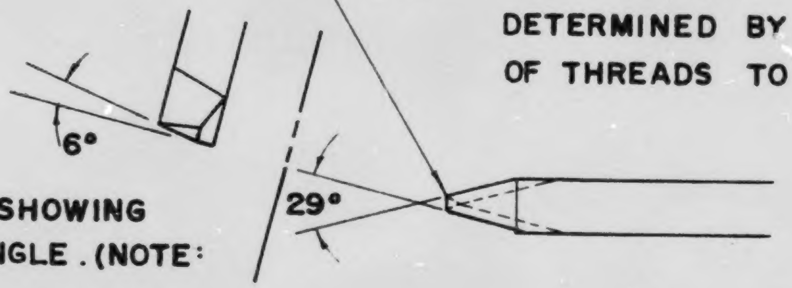
PROJECT #30

COURSES: Measuring, Layout Work, Lathe, Grinding

MATERIALS: One Each - High Speed Steel Tool Blank 5/16" Square

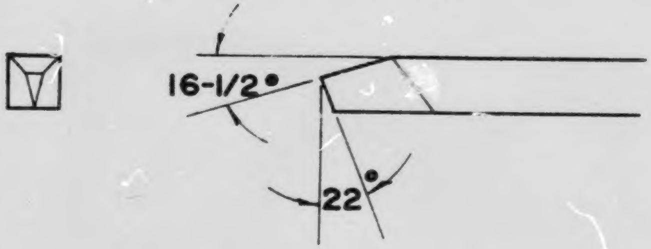
TASK:

L - 21	Grinding a threading tool
M - 34	Measuring with a vernier caliper
G - 1	Dressing the wheel for grinding
G - 2	Off-hand grinding
L/O - 3	Use a combination set
M - 21	Using an acme thread gage



NOTE: THE WIDTH OF THE FLAT IS DETERMINED BY THE NUMBER OF THREADS TO BE CUT.

AUXILIARY VIEW SHOWING 6° CLEARANCE ANGLE. (NOTE: GRIND 2 SIDES)



MATERIAL: 5/16 X 5/16 HIGH SPEED STEEL TOOL BIT.

TOLERANCE: + − 2

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			

TITLE ACME THREADING TOOL

NO 299

293

30

55

BRUNING 40-105

ACME THREADING TOOL

PROJECT #30

SPECIAL INSTRUCTIONS: A thorough knowledge of the bench grinder should precede this operation.

Wooden blocks on a belt sander may conserve stock.

Review the procedure in Project #17 - 20.

PROCEDURES:

1. Check the tool blank size
    a. Use a vernier caliper
2. Dress the grinding wheel
3. Grind the $16\frac{1}{2}^{\circ}$ negative rake angle
    a. Use a protractor to check the angle
4. Use an acme thread gage to scribe the 29° included angle
    a. Use a pencil
5. Grind the side clearance angle 8° and the side cutting edge angle
    a. These two angles must be ground at the same grind
    b. Check the angles with a protractor
6. Grind the same angles on the other side
7. Now the 29° angle may be checked with an acme thread gage
8. Grind the flat
    a. Check with an acme thread gage
9. Hone all edges slightly

REFERENCES

1. Krar, S. F. and Oswald, J. W.: Grinding Technology. Albany: Delmar Publishers, 1974.

2. Lascoe, Nelson, Porter: Machine Shop - Operations and Setups. Chicago: American Technical Society, 1973

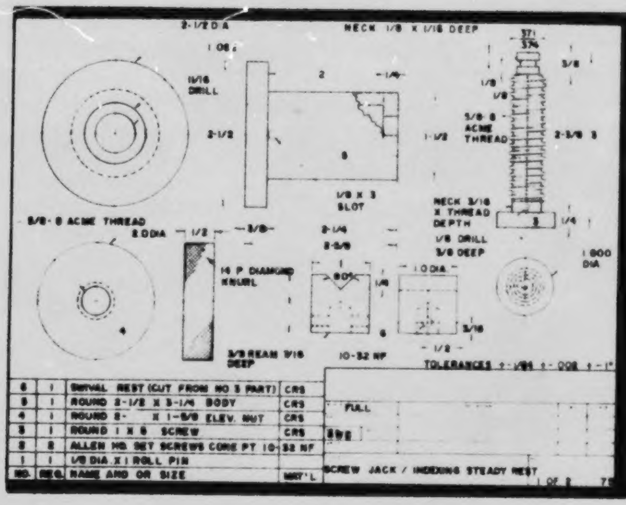
3. Oberg, Erik and Jones, F. D.: Machinery's Handbook. New York, N.Y.: Industrial Press Inc., 1976

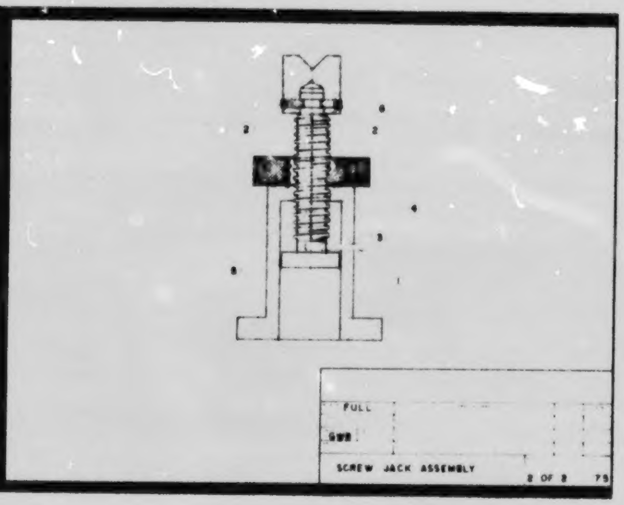
4. Morse: Machinist's Practical Guide. New Bedford, Mass: Morse Cutting Tools Division, 1978

5. Krar, S.F.; Oswald, J. W. and St. Amond, J. E.: Technology of Machine Tools. New York: McGraw-Hill Book Company, Gregg Division, 1977

MACHINE SHOP PROJECTS

LATHE
Projects 31-48


2-1/2 DIA
NECK 1/8 X 1/16 DEEP
.371
.374
1.062
11/16 DRILL
2
1/4
3/8
1/8
1/8
5/8-8 ACME THREAD
2-1/2
5
1-1/2
2-3/8 3
1/8 X 3 SLOT
NECK 3/16 X THREAD DEPTH
1
1/4
5/8-8 ACME THREAD
2.0 DIA
1/2
3/8
2-1/4
2-5/8
1/8 DRILL
3/8 DEEP
1.000 DIA
14 P DIAMOND KNURL
1
60°
1/4
1.0 DIA
4
6
3/16
1/2
3/8 REAM 7/16 DEEP
10-32 NF
TOLERANCES ± 1/64 ± .005 ± 1°
6 1 SWIVAL REST (CUT FROM NO 3 PART) CRS
5 1 ROUND 2-1/2 X 3-1/4 BODY CRS
4 1 ROUND 2- X 1-5/8 ELEV. NUT CRS
3 1 ROUND 1 X 6 SCREW CRS
2 2 ALLEN HD. SET SCREWS CONE PT 10-32 NF
1 1 1/8 DIA. X 1 ROLL PIN
NO. REQ. NAME AND OR SIZE MAT'L
FULL
SWB
SCREW JACK / INDEXING STEADY REST
1 OF 2 75


6
2
2
4
3
5
1
FULL
SWB
SCREW JACK ASSEMBLY
2 OF 2 75

STUDENT MANUAL

Georgia Department of Education

MACHINE SHOP PROJECTS

Developed Under a Grant from

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1980

MACHINE SHOP PROJECTS

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This project was developed under a grant from:

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Georgia Department of Education

Project Numbers: 98251 and 28252

to:

Augusta Area Vocational-Technical School

Author:
Raymond E. Westbrook
Instructor, Machine Shop

Drawings:
George W. Baggs, Jr.
Instructor, Drafting and Design

TABLE OF CONTENTS

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Part C: PROJECTS - 1-101:

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Information Sheet
Project Drawings
Fabrication Procedures

Part D: REFERENCES

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PURPOSE

A student in Machine Shop must learn by doing. Although lectures, reading assignments, and audio-visual aids are very necessary, these methods alone will never produce a good machinist. The combination of both classroom and shop practice is essential to your training. The purpose of this Shop Project Guide is to give the necessary shop experience to complement your classroom training. This guide is based on the author's years of practical experience as a skilled machinist and as a teacher in the field. Each skill needed to complete a phase of your training has been identified. Next, projects have been devised to give hands-on experience for each skill with enough repetition so that you will become capable of using each tool or attachment for the particular machine or operation being taught. Your instructor will help you select or will assign the projects in the necessary order. You will also find the end products of these projects will be useful tools that will help in your training that follows. This serves not only to make the projects more interesting, but more enjoyable to construct. This practical training along with classroom instruction and applied learning can bring you a rewarding future as a skilled tradesman.

PROJECT LISTING (CATEGORIZED)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench

*11. Pipe flange assembly

*12. C-clamp

*13. Block and tackle

*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects

*16. Jack Stand

*17. Gear puller

18. Tool post base

308

MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (genreal purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. 1/4" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
40. Dead center
41. Plumb bob

42. Dumbbell set
43. Taper plug gage
44. Rocker dish
45. Rocker
46. Tool post body
47. Circle cutter
48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II
*50. Fly cutter
51. Tooth pick holder
*52. Pipe center
53. Taper ring gage
54. Set up bolt 1/2" x 4"
55. Set up bolt 1/2" x 6"
56. Set up bolt 1/2" x 8"
57. Set up bolt 3/8" x 4"
58. Set up bolt 3/8" x 6"
59. Drill reducer
60. Tap drill extension (1/4" - 20 NC tap drill)
61. Tap drill extension (5/16" - 18 NC tap drill)
62. Boring bar holder body jig
63. Boring bar holder body
*64. Boring bar holder base
65. Boring bar holder inner body
66. Boring bar holder base jig

67. Precision measuring tool block

*68. Milling arbor #40 - 3/8"

*69. Milling arbor #40 - 1/5"

*70. Milling arbor #40 - 5/8"

*71. Milling arbor #40 - 3/4"

*72. Lathe arbor

73. Mallet

74. Acme thread/boring tool

*75. Screw jack/indexing steady rest

76. Lathe chuck wrench

77. Internal pipe wrench

78. Buffer/grinder shaft

SHAPER

79. Splitting wedge

80. Flat strap clamp

*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks 1

*83. V-blocks

84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge

86. Solid key seat

87. Water valve wrench

88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. 1/4" pitch, 1' lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

x

MACHINE SHOP

PROJECT #31

MICROMETER TEST BLOCK

313

MICROMETER TEST BLOCK

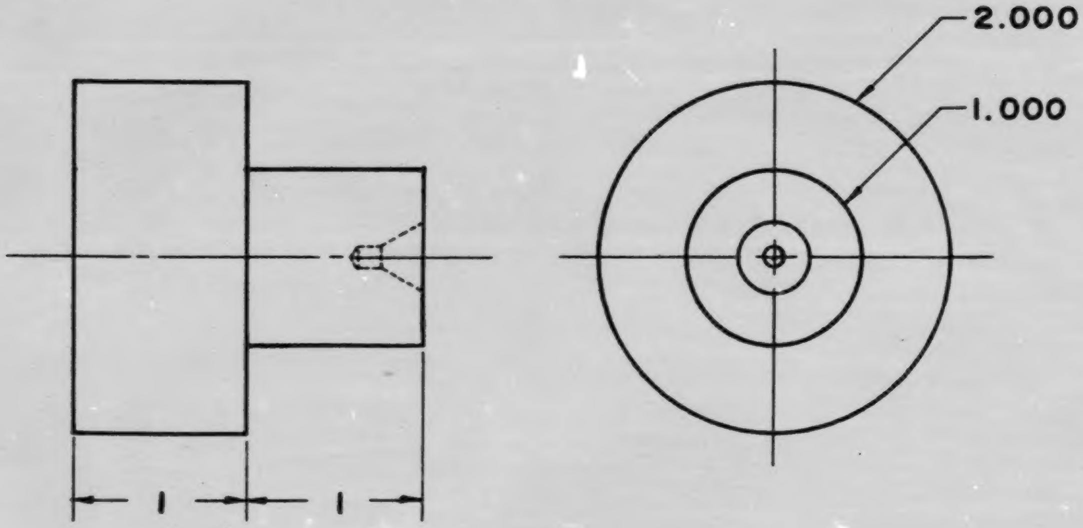
PROJECT #31

COURSES: Measuring, Layout Work, Saws, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 2" diameter x 2¼" Long

TASK:

L - 2	Grind a roughing tool
L - 3	Grind a turning tool
L - 4	Grind a facing tool
S - 1	Cut to length on a horizontal band or power hacksaw
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 14	Turning a shoulder on a lathe
M - 30	Measuring with an outside micrometer caliper
M - 2	Measuring a shoulder or step
L/O - 1	Use a layout table
L/O - 13	Use a vernier height gage
M - 35	Measuring with a vernier height gage
M - 8	Measuring with a rule depth gage



MATERIAL: I EA. CRS ROUND 2" DIA. X 2-1/4 LONG

TOLERANCES: +-1/64 · +-.002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. CKD.			
AP'VD.			

TITLE
MICROMETER TEST BLOCK

NO. 316

315

31

MICROMETER TEST BLOCK

PROJECT #31

SPECIAL INSTRUCTIONS: This block may be used to check outside micrometers from 0-3 inches. Check a 0-1 by screwing the spindle to the anvil. Calibrate it if necessary. With the same micrometer check the reading of the small diameter. In the same place on the small diameter check a 2" micrometer and compare readings. Repeat this operation for checking a 3" micrometer against a 2" micrometer.

PROCEDURES:

1. Grind a roughing tool
2. Grind a turning tool
3. Grind a facing tool
4. Cut stock to 2¼" long
   a. Use a horizontal band saw
5. Chuck in a lathe
   a. Use a three-jaw chuck
   b. Chuck on 3/4"
6. Face stock square
   a. Use facing tool
7. Center drill the stock
8. Insert a center
9. Rough turn the stock
10. Finish turn the stock
    a. Check with an outside micrometer
    b. Measure the length with a scale
11. Chamfer all edges
12. Remove from the lathe
13. Layout the length.

317

    a. Use layout table
    b. Use a vernier height gage
14. Re-chuck in a three-jaw chuck
    a. Chuck on small end
15. Face to layout line
    a. Chamfer all edges
16. Remove from lathe
17. Check lengths
    a. Use vernier height gage for over all height
    b. Use rule depth gage for length of small diameter

MACHINE SHOP

PROJECT #32

FLARING TOOL

FLARING TOOL

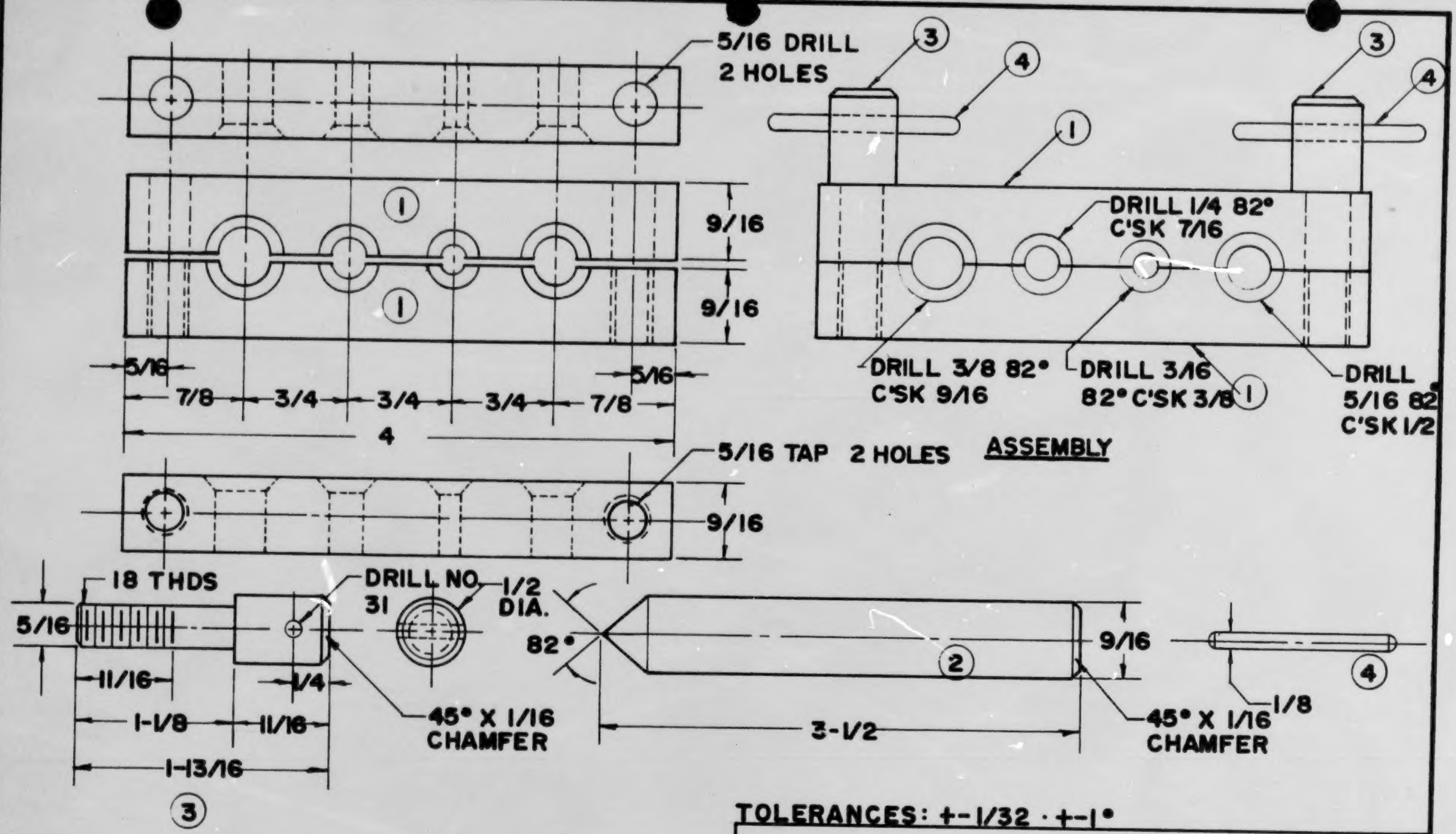
PROJECT #32

COURSES: Measuring, Layout, Bench Work, Saws, Drill Presses, Lathe

MATERIALS:
Two each - Cold Rolled Steel Square - 9/16" x 9/16" x 4 1/8" Long
One each - Cold Rolled Steel Round - 9/16" Diameter x 3 5/8" Long
Two each - Cold Rolled Steel Round - 1/2" Diameter x 3 7/8" Long
Two each - Cold Rolled Steel Round - 1/8" Diameter x 1 1/2" Long

TASK:

S - 1	Cut to length on a horizontal band or power hacksaw
B - 6	Use a file
L/O - 2	Use a scriber
L/O - 5	Use a layout blue
L/O - 3	Use a combination set
D - 1	Drill on a drill press
D - 7	Tapping on a drill press
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 14	Turning a shoulder on a lathe
B - 8	Use a die
M - 30	Measuring with an outside micrometer
M - 2	Measuring a shoulder or a step
B - 5	Use a hand hacksaw
L - 28	Cutting a taper using a compound rest
D - 4	Countersinking on a drill press


5/16 DRILL
2 HOLES
①
9/16
9/16
5/16
5/16
7/8
3/4
3/4
3/4
7/8
4
5/16 TAP 2 HOLES
9/16
③
④
DRILL 1/4 82°
C'SK 7/16
DRILL 3/8 82°
C'SK 9/16
DRILL 3/16
82° C'SK 3/8
DRILL
5/16 82°
C'SK 1/2
ASSEMBLY
18 THDS
5/16
DRILL NO.
31
1/2
DIA.
11/16
1/4
1-1/8
11/16
1-13/16
45° X 1/16
CHAMFER
82°
②
9/16
3-1/2
45° X 1/16
CHAMFER
1/8

TOLERANCES: +-1/32 · +-1°

NO.	REQ.	NAME AND OR SIZE	MAT.
4	2	1/8 DIA. X 1-1/2 PIN	CRS
3	2	1/2 DIA. X 3-7/8 SCREW	CRS
2	1	9/16 DIA. X 3-5/8 PUNCH	CRS
1	2	9/16 X 9/16 X 4-1/8 JAWS	CRS

321

	REVISIONS	BY	DATE
SCALE FULL			
DATE			
DR'N GWB CKD			
AP'VD			

TITLE FLARING TOOL

NO 322

32

FLARING TOOL

PROJECT #32

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PRECEDURES:

JAWS

1. Cut stock to length
2. File the ends square and to length
3. Layout and drill the 5/16" holes
4. Clamp the two jaws together
    a. Use a c-clamp
5. Spot the bottom jaw with the 5/16" drill
6. Drill and tap the 5/16" tap hole

SCREW

7. Chuck in a lathe
    a. Use a three-jaw chuck
8. Face one end
9. Turn the small diameter to length
10. Thread with a die
11. Reverse end
12. Face second end
13. Turn the small diameter to length
    a. Measure diameter with an outside micrometer
    b. Measure length with a steel rule
14. Thread with a die
15. Cut with a saw

323

    a. Use a hand hacksaw

16. Face to length

17. Chamfer

18. Remove from lathe

19. Layout and drill the holes

PUNCH

20. Cut stock to length

    a. Allow 1/8" for facing in the lathe

21. Face and chamfer the first end

22. Reverse the stock and face to length

23. Cut the angle

    a. Use the compound rest

24. Case harden

HANDLES

25. Cut to length

    a. Use a hand hacksaw

26. File corners

ASSEMBLY

27. Assemble all parts

    a. Place a 1/32 shim between the jaws

28. Layout and center punch the counterbored holes

29. Drill the holes

30. Counterbore the holes

    a. One side only

31. Disassemble

32. Chamfer all edges

33. Case harden the jaws

324

MACHINE SHOP

PROJECT #33

¼" PIN PUNCH

¼" PIN PUNCH

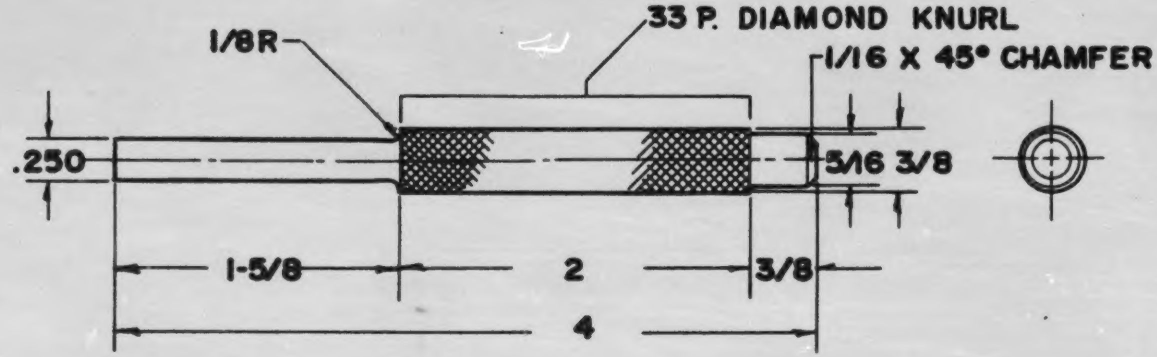
PROJECT #33

COURSES: Measuring, Lathe

MATERIALS: One Each - Drill Rod 3/8" diameter x 4 1/8" long

TASK:

M - 30	Measuring with an outside micrometer caliper
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 15	Knurling in a lathe
L - 14	Turning a shoulder in a lathe
L - 19	Grinding in a lathe
L - 18	Polishing in a lathe


33 P. DIAMOND KNURL
1/8R
1/16 X 45° CHAMFER
.250
5/16
3/8
1-5/8
2
3/8
4

MATERIAL: 1 EA. DRILL ROD 3/8 DIA. X 4-1/8 LONG

TOLERANCES: +- 1/64 · +-.003

327

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			
TITLE 1/4 PIN PUNCH	NO. 328		

33

¼" PIN PUNCH

PROJECT #33

PROCEDURES:

1. Check the stock size
2. Cut to 4 1/8" length
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face one end
5. Knurl
6. Turn the 5/16" diameter 3/8" long
7. Chamfer the end
8. Reverse ends
    a. Chuck on the knurl
        (1) Use false jaws
9. Face to length
10. Turn the .250 diameter
    a. Allow .010 for grinding
11. Remove from lathe
12. Heat treat
13. Place in a lathe
    a. Use a three-jaw chuck
14. Grind to .250"
15. Grind the face
16. Polish in the lathe

329

MACHINE SHOP

PROJECT #34

3/16" PIN PUNCH

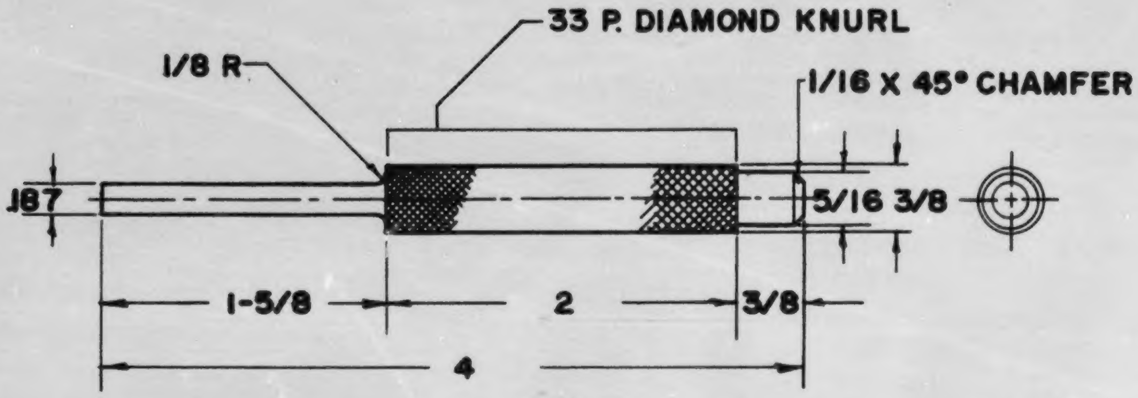
3/16" PIN PUNCH

PROJECT #34

COURSES: Measuring, Lathe

MATERIALS: One Each - Drill Rod 3/8" diameter x 4 1/8" long

TASK:	M - 30	Measuring with an outside micrometer caliper
	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 15	Knurling in a lathe
	L - 14	Turning a shoulder in a lathe
	L - 19	Grinding in a lathe
	L - 18	Polishing in a lathe


33 P. DIAMOND KNURL
1/8 R
1/16 X 45° CHAMFER
.187
5/16
3/8
1-5/8
2
3/8
4

MATERIAL: 1 EA. DRILL ROD 3/8 DIA. X 4-1/8 LONG

TOLERANCES: +− 1/64 · +−.003

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			

TITLE 3/16 PIN PUNCH

NO 333

332

34

3/16" PIN PUNCH

PROJECT #34

PROCEDURES: 1. Check the stock size

2. Cut to 4 1/8" length
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face one end
5. Knurl
6. Turn the 5/16" diameter 3/8" long
7. Chamfer the end
8. Reverse ends
    a. Chuck on the knurl
        (1) Use false jaws
9. Face the length
10. Turn the .187" diameter
    a. Allow .010 for grinding
11. Remove from lathe
12. Heat treat
13. Place in a lathe
    a. Use a three-jaw chuck
14. Grind to .187"
15. Grind the face
16. Polish in the lathe

334

MACHINE SHOP

PROJECT #35

1/8" PIN PUNCH

335

1/8" PIN PUNCH

PROJECT #35

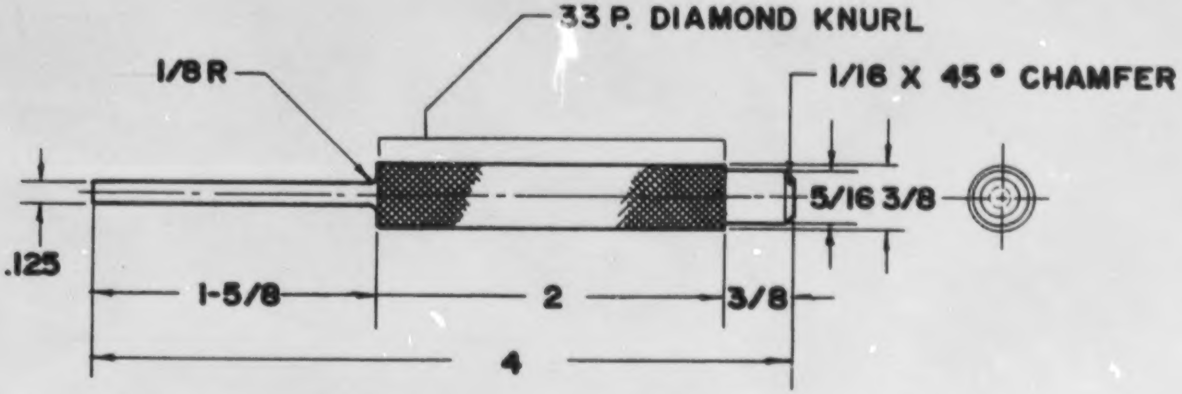
COURSES: Measuring, Lathe

MATERIALS: One Each - Drill Rod 3/8" diameter x 4 1/8" long

TASK:

M - 30	Measuring with an outside micrometer caliper
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 15	Knurling in a lathe
L - 14	Turning a shoulder in a lathe
L - 17	Filing in a lathe
L - 19	Grinding in a lathe
L - 18	Polishing in a lathe

336


33 P. DIAMOND KNURL
1/8 R
1/16 X 45° CHAMFER
5/16
3/8
.125
1-5/8
2
3/8
4

MATERIAL: 1 EA. DRILL ROD 3/8 DIA. X 4-1/8 LONG

TOLERANCES: +- 1/64 · +- .003

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB / CKD.			
AP'VD.			

TITLE 1/8 PIN PUNCH

NO 338 35

337

1/8" PIN PUNCH

PROJECT #35

PROCEDURES:

1. Check the stock size
2. Cut to 4 1/8" long
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face one end
5. Knurl
6. Turn the 5/16" diameter 3/8" long
7. Chamfer the end
8. Reverse ends
    a. Chuck on the knurls
        (1) Use false jaws
9. Face to length
10. Turn the .150" for grinding
11. File parallel
    a. Allow .015" for grinding
12. Remove from the lathe
13. Heat treat
14. Place in a lathe
    a. Use a three-jaw chuck
15. Grind to .125"
16. Grind the face
17. Polish in the lathe

MACHINE SHOP

PROJECT #36

CENTER PUNCH

340

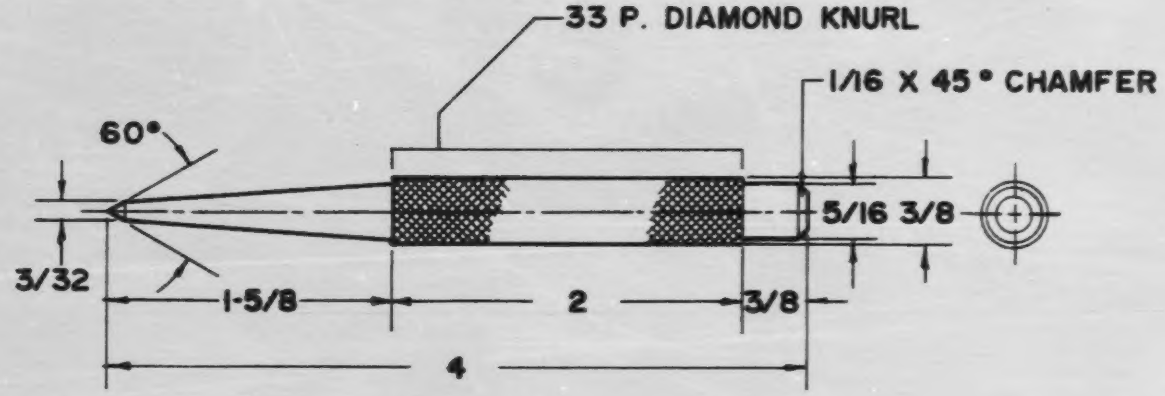
CENTER PUNCH

PROJECT #36

COURSES: Measuring, Lathe

MATERIALS: One Each - Drill Rod 3/8" diameter x 4 1/8" long

TASK:	M - 30	Measuring with an outside micrometer caliper
	M - 2	Measuring a shoulder or step
	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 15	Knurling on a lathe
	L - 14	Turning a shoulder on a lathe
	L - 28	Cutting a taper with the compound rest
	L - 19	Grinding in a lathe
	L - 18	Polishing in a lathe


33 P. DIAMOND KNURL
1/16 X 45° CHAMFER
60°
3/32
5/16
3/8
1-5/8
2
3/8
4

MATERIAL: 1 EA. DRILL ROD 3/8 DIA. X 4-1/8 LONG

TOLERANCES: + – 1/64 · + – 1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			

TITLE CENTER PUNCH

NO 343

342

CENTER PUNCH

PROJECT #36

PROCEDURES:

1. Check the stock size
2. Cut to 4 1/8" long
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face one end
5. Knurl
6. Turn the 5/16" diameter 3/8" long
7. Chamfer the end
8. Reverse ends
    a. Chuck on the knurls
        (1) Use false jaws
9. Straight turn to 5/16"
10. Turn the long angle
11. Turn the 60° angle
12. Remove from the lathe
13. Heat treat
14. Place in the lathe
    a. Use a three-jaw chuck
15. Grind the point
    a. Use a tool post grinder
    b. Grind to length
16. Polish in the lathe

344

MACHINE SHOP

PROJECT #37

PRICK PUNCH

345

PRICK PUNCH

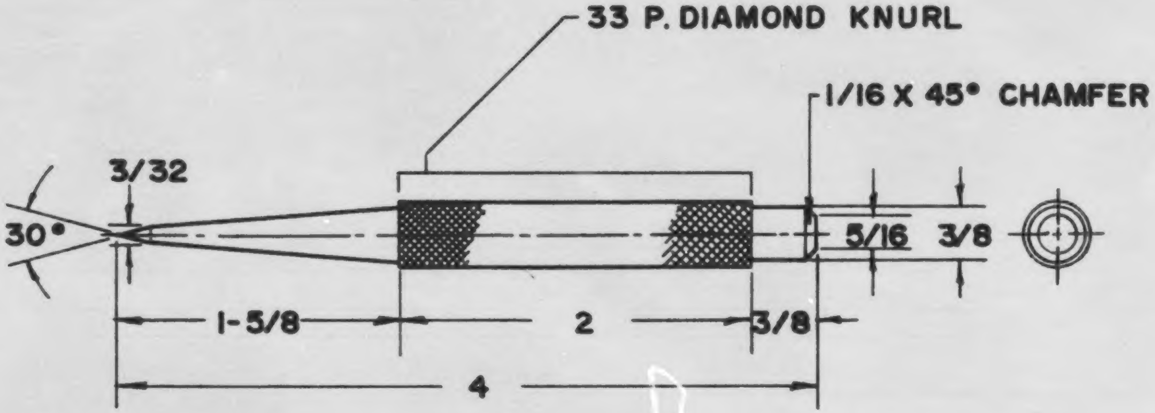
PROJECT #37

COURSES: Measuring, Lathe

MATERIALS: One Each - Drill Rod 3/8" diameter x 4 1/8" long

TASK:	M - 30	Measuring with an outside micrometer caliper
	M - 2	Measuring a shoulder or step
	L - 6	Chucking on a three-jaw chuck
	L - 8	Facing on a lathe
	L - 15	Knurling on a lathe
	L - 14	Turning a shoulder on a lathe
	L - 28	Cutting a taper with the compound rest
	L - 19	Grinding in a lathe
	L - 18	Polishing in a lathe

346


33 P. DIAMOND KNURL
1/16 X 45° CHAMFER
3/32
30°
5/16
3/8
1-5/8
2
3/8
4

MATERIAL: 1 EA. DRILL ROD 3/8 DIA. X 4-1/8 LONG

TOLERANCES: +− 1/64 · +− 1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD			
AP'VD.			

TITLE PRICK PUNCH

NO 348

347

37

PRICK PUNCH

PROJECT #37

PROCEDURES:

1. Check the stock size
2. Cut to 4 1/8" long
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face one end
5. Knurl
6. Turn the 5/16" diameter 3/8" long
7. Chamfer the end
8. Reverse ends
    a. Chuck on the knurls
        (1) Use false jaws
9. Straight turn to 5/16"
10. Turn the long angle
11. Turn the 30° angle
12. Remove from the lathe
13. Heat treat
14. Place in the lathe
    a. Use a three-jaw chuck
15. Grind the point
    a. Use a tool post grinder
    b. Grind to length
16. Polish in the lathe

MACHINE SHOP

PROJECT #38

NAIL SET

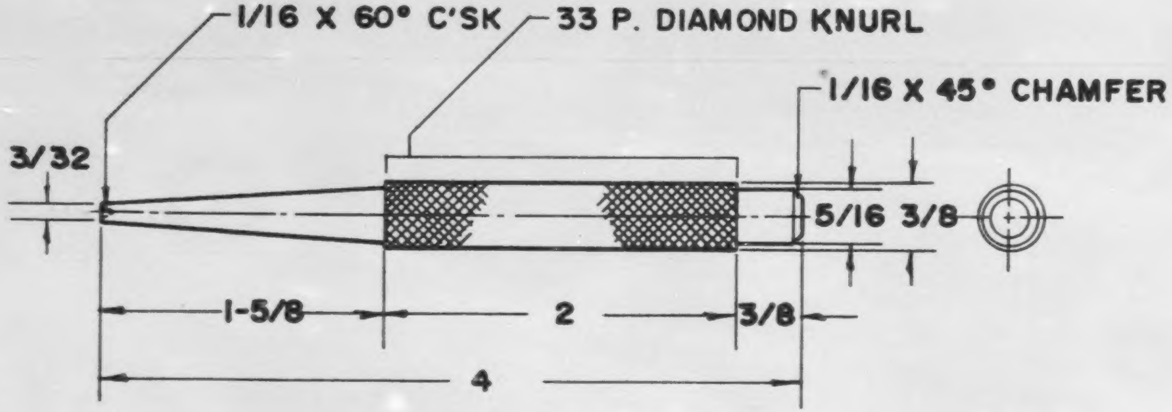
NAIL SET

PROJECT #38

COURSES: Measuring, lathe

MATERIALS: One Each - Drill Rod 3/8" diameter x 4 1/8" long

TASK:	M - 30	Measuring with an outside micrometer caliper
	M - 2	Measuring a shoulder or step
	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 15	Knurling on a lathe
	L - 14	Turn a shoulder on a lathe
	L - 28	Cutting a taper with the compound rest
	L - 19	Grinding in a lathe
	L - 10	Center drilling in a lathe
	L - 18	Polishing in a lathe


1/16 X 60° C'SK
33 P. DIAMOND KNURL
1/16 X 45° CHAMFER
3/32
5/16
3/8
1-5/8
2
3/8
4

MATERIAL: 1 EA. DRILL ROD 3/8 DIA. X 4-1/8 LONG

TOLERANCES: + − 1/64 · + − 1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD.			
AP'VD.			

TITLE NAIL SET

NO. 353

352

BRUNING 40-105

NAIL SET

PROJECT #38

PROCEDURES:

1. Check the stock size
2. Cut to 4 1/8" long
3. Chuck in a lathe
    - a. Use a three-jaw chuck
4. Face one end
5. Knurl
6. Turn the 5/16" diameter 3/8" long
7. Chamfer the end
8. Reverse ends
    - a. Chuck on the knurls
        - (1) Use false jaws
9. Straight turn to 5/16"
10. Turn the long angle
11. Countersink
    - a. Use a #2 center drill
12. Remove from lathe
13. Heat treat
14. Polish in the lathe

354

MACHINE SHOP

PROJECT #39

SCRIBER

355

SCRIBER

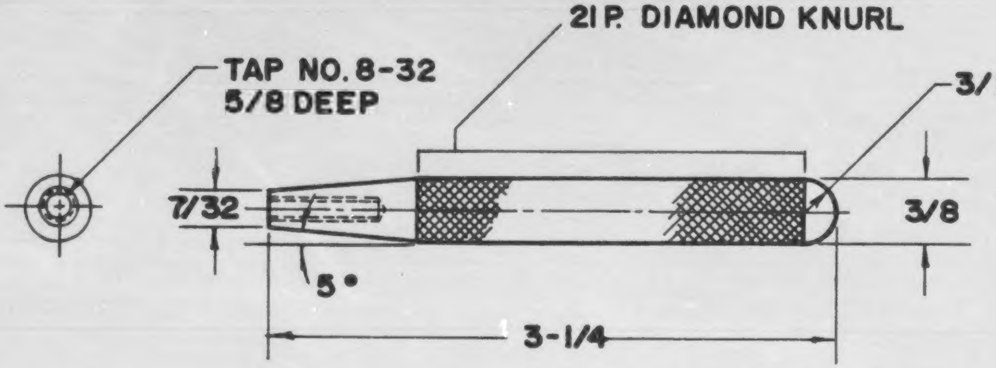
PROJECT #39

COURSES: Measuring, Bench Work, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 3/8" diameter x 5" long
One Each - Drill Rod 5/32" diameter x 3" long

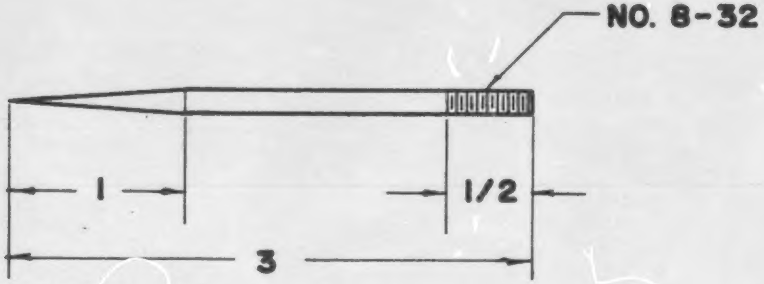
TASK:

M - 15	Measuring with an outside caliper
M - 6	Measure with the block and rule method
M - 8	Use a die
L - 17	Filing in a lathe
M - 30	Measuring with an outside micrometer caliper
L - 8	Facing in a lathe
L - 15	Knurling on a lathe
L - 28	Cutting a taper with the compound rest
L - 11	Drilling in a lathe
L - 24	Tapping in a lathe
M - 18	Measuring with a radius and fillet gage



21P. DIAMOND KNURL
TAP NO. 8-32
5/8 DEEP
3/16 R
7/32
3/8
5°
3-1/4

HANDLE



MARKER

MATERIAL: 1 EA. CRS ROUND 3/8 DIA X 5 LONG
1 EA. DRILL ROD 5/32 DIA. X 3 LONG

TOLERANCES: + − 1/32 · + − 1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB CKD.			
AP'VD.			
TITLE SCRIBER	NO 358		

357

BRUNING 40 105

SCRIBER

PROJECT #39

PROCEDURES: Marker

1. Check stock size
2. Cut to length
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Thread end
    a. Use a die
5. Reverse ends
6. File the point
7. Heat treat the point

Handle

8. Check stock size
9. Chuck in a lathe
10. Face
11. Center drill
    a. Use a #2 center drill
12. Insert a dead center
13. Knurl
14. Cut the taper
    a. Use the compound rest
15. Drill and tap
16. Chamfer the edges
17. Remove from lathe
18. Cut to length

    a. Allow 1/8" for facing

19. Face to length
20. File the radius
    a. Use a radius and fillet gage
21. Assemble

MACHINE SHOP

PROJECT #40

DEAD CENTER

DEAD CENTER

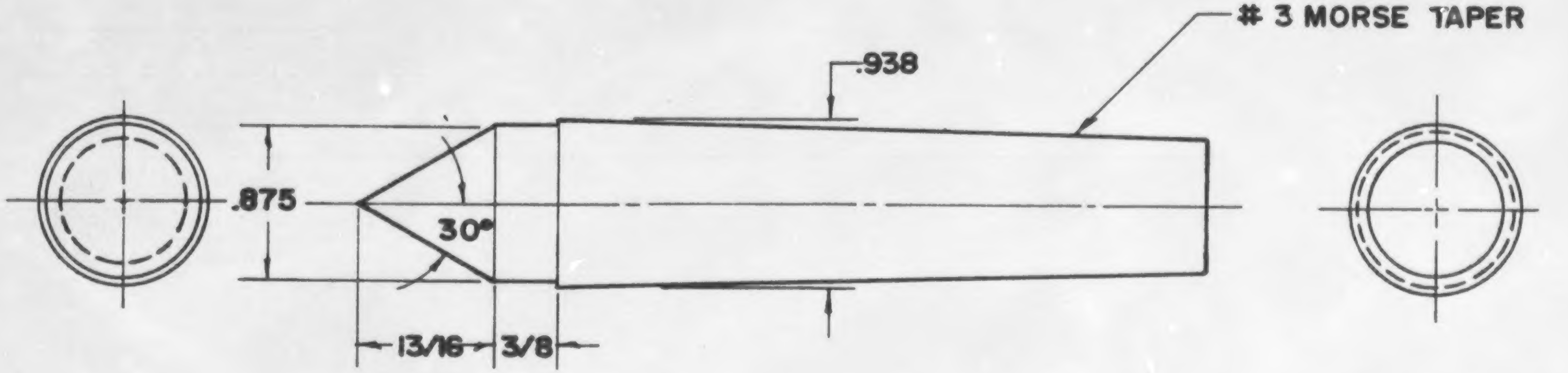
PROJECT #40

COURSES: Lathe

MATERIALS: One Each - Tool Steel #3 1" diameter x 5" long
(OR)
One Each - Cold Rolled Round 1" diameter x 5" long (carborize)

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 9	Turning in a lathe
L - 29	Cutting a taper with the taper attachment
L - 28	Cutting a taper with the compound rest
L - 18	Polishing in a lathe
L - 19	Grinding in a lathe



# 3 MORSE TAPER
.938
.875
30°
13/16
3/8

MATERIAL: 1 EA. TOOL STEEL # 3 1" DIA. X 5 LONG

TOLERANCES: + − 1/64 · + − .003 · + − 1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD.			

TITLE DEAD CENTER

NO. 364

40

363

BRUNING 40-105

DEAD CENTER

PROJECT #40

SPECIAL INSTRUCTIONS: Cold rolled round may be used for practice.

PROCEDURES:

1. Check stock size
2. Chuck in a lathe
    a. Use a three-jaw chuck
    b. Chuck on 1"
3. Face
4. Center drill
5. Insert center
6. Straight turn to .938"
    a. Turn as close to chuck as possible
7. Turn taper
    a. Use taper attachment
8. Check taper
    a. Use a taper ring gage
9. Remove from chuck
10. Remove chuck from lathe
11. Insert taper in spindle
12. Face to length
13. Straight turn to .875" to taper
14. Cut 60° included angle
    a. Use compound rest
15. Heat treat
16. Polish in the lathe
17. Grinding in the lathe may be necessary

MACHINE SHOP

PROJECT #41

PLUMB BOB

PLUMB BOB

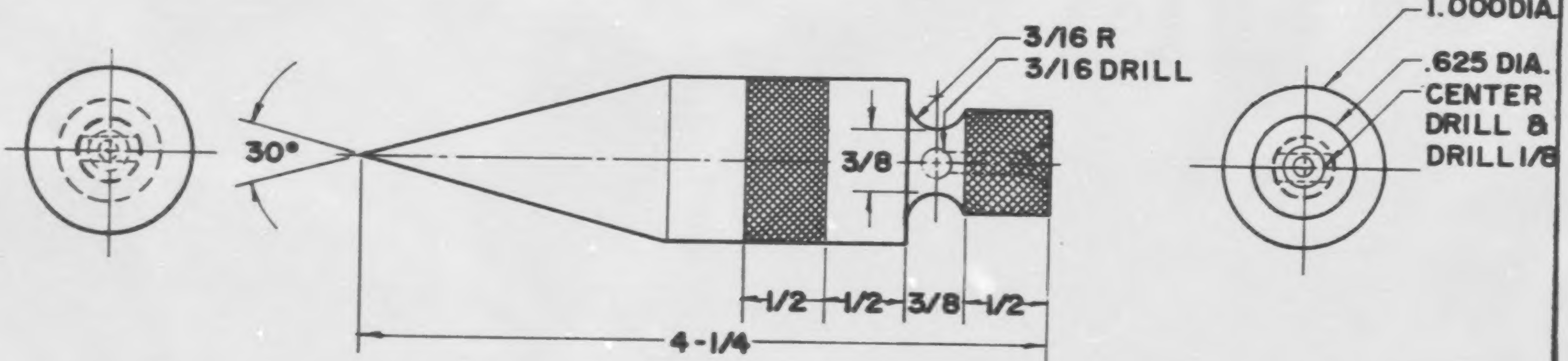
PROJECT #41

COURSES: Measuring, Drilling, Lathe

MATERIALS: One Each - Brass Free Machining 1" diameter x 4½" long

TASK:

L - 5	Grinding a necking tool
M - 18	Measuring with a radius and fillet gage
L - 3	Grind a turning tool
L - 6	Chucking in a three-jaw chuck
L - 10	Center drilling in a lathe
L - 9	Turning in a lathe
L - 35	Necking in a lathe
L - 15	Knurling on a lathe
L - 36	Cutting a radius in a lathe
L - 11	Drilling in a lathe
L - 7	Chucking in a four-jaw chuck
M - 41	Using a dial indicator
L - 28	Cutting a taper with the compound rest
D - 1	Drilling on a drill press
L - 18	Polishing in a lathe


30°
3/16 R
3/16 DRILL
3/8
1/2
1/2
3/8
1/2
4-1/4
1.000 DIA.
.625 DIA.
CENTER
DRILL &
DRILL 1/8

MATERIAL: BRASS FREE MACHINING 1" DIA. X 4-1/2

TOLERANCES: +-1/64 · +-1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB CKD.			
AP'VD			

TITLE PLUMB BOB

NO. 369 41

368

BRUNING 40-105

PLUMB BOB

PROJECT #41

SPECIAL INSTRUCTIONS: To assemble use an 1/8" piece of brass welding rod 3/8" long. Insert a string through the center drilled hole and tie it on the center of welding rod. Place the rod through the 3/16 drilled hole, centering the string.

PROCEDURES:

1. Grind a necking tool
    a. Use a 3/8" tool blank
2. Grind a 3/16" radius tool
    a. Use a radius and fillet gage
3. Grind a turning tool
4. Check the stock size
5. Chuck stock in a lathe
    a. Use a three-jaw chuck
    b. Chuck on 2"
6. Center drill
7. Turn the 5/8" diameter
8. Neck for the radius
9. Knurl all surfaces to be knurled
10. Cut radius
11. Drill the 1/8" hole
12. Reverse ends
    a. Use a four-jaw chuck
    b. True stock
        (1) Use a dial indicator 370
    c. Use false jaws
13. Face to length

14. Cut taper

    a. Use the compound rest

15. Drill the 3/16" hole

16. Polish the stock

14. Cut taper

    a. Use the compound rest

15. Drill the 3/16" hole

16. Polish the stock

MACHINE SHOP

PROJECT #42

DUMBBELL SET (17 Lbs.)

DUMBBELL SET (17 Lbs.)

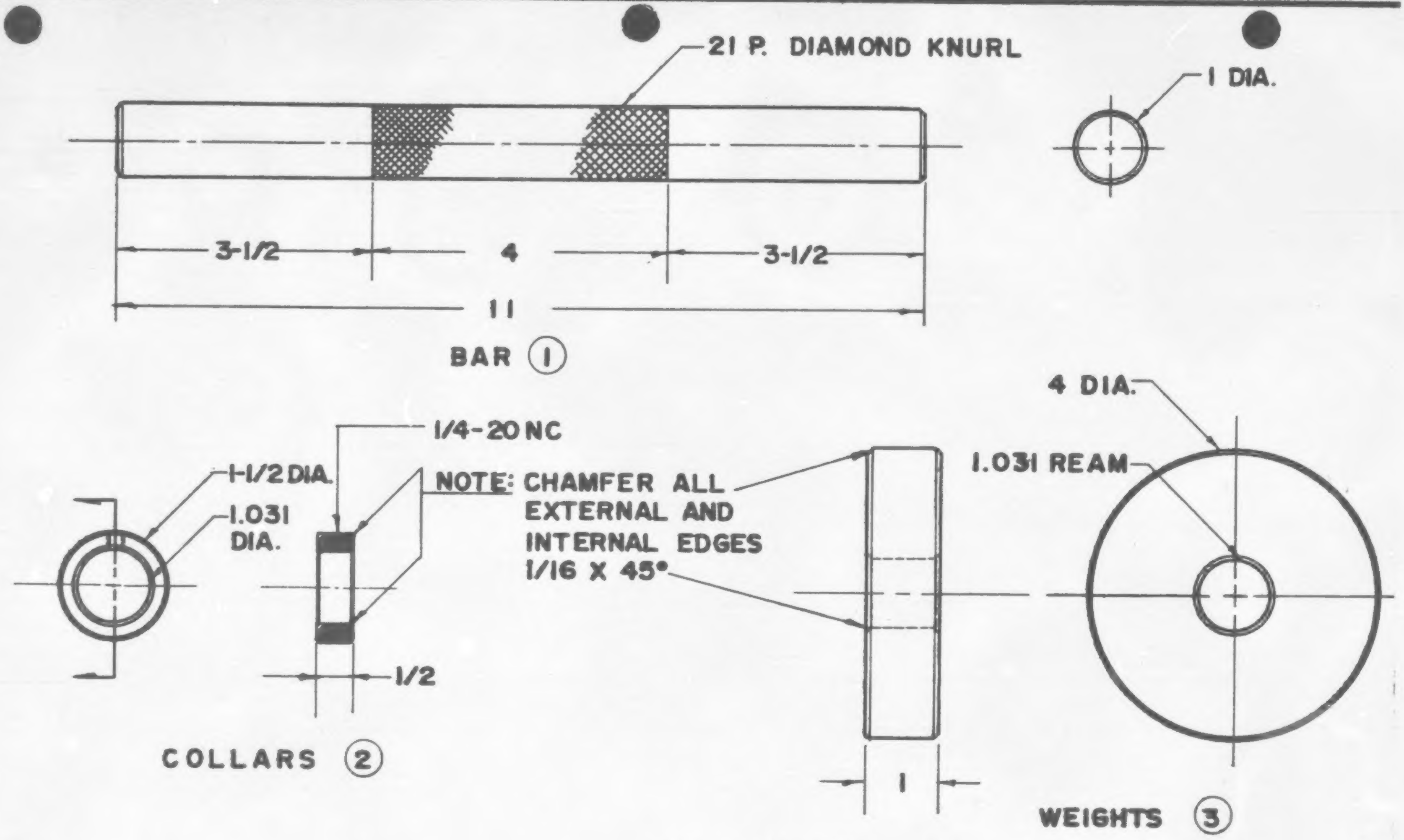
PROJECT #42

COURSES: Measuring, Drill Presses, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 1" diameter x 11½" long
Four Each - Cold Rolled Steel Round 1½" diameter x 1" long
Four Each - Cold Rolled Steel Round 4" diameter x 1½" long
Four Each - ¼-20 NC Set Screws

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 33	Use a steady rest on a lathe
L - 15	Knurling on a lathe
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
M - 17	Measuring with an inside caliper using a micrometer
L - 31	Measuring with an inside micrometer caliper
M - 37	Measuring with a telescoping gage
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press



21 P. DIAMOND KNURL
1 DIA.
3-1/2
4
3-1/2
11
BAR ①
4 DIA.
1/4-20 NC
1.031 REAM
1-1/2 DIA.
1.031 DIA.
1/2
COLLARS ②
1
WEIGHTS ③

NOTE: CHAMFER ALL EXTERNAL AND INTERNAL EDGES 1/16 X 45°

TOLERANCES: ± 1/64 · ± .003

NO.	REQ.	NAME AND OR SIZE	MAT.
4	4	1/4-20NC SET SCREWS (NOT SHOWN)	
3	4	ROUND 4" DIA. X 1-1/2	CRS
2	4	ROUND 1-1/2 X 1	CRS
1	1	ROUND 1" DIA. X 11-1/2	CRS

SCALE 1/2 SIZE	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD			
AP'VD.			

TITLE DUMBBELL SET (17 LBS.)

NO. 376

BRUNING 10-105

DUMBBELL SET (17 Lbs.)

PROJECT #42

PROCEDURES: Bar

1. Check stock size
2. Cut to length
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face one end
5. Chamfer
6. Reverse ends
    a. Chuck with 2" in the chuck
    b. Use a steady rest
7. Face to length
8. Chamfer
9. Knurl

Weights

1. Check stock size
2. Cut to length
    a. Allow ½" for facing
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face
5. Center drill
6. Drill
7. Ream
8. Chamfer
9. Reverse ends

377

10. Face to length
11. Chamfer
12. Check hole size
    a. Use an inside caliper and a micrometer

Collar

1. Check stock size
2. Cut to length
    a. Allow ¼" for facing
3. Chuck in a lathe
4. Face one end
5. Center drill
6. Drill
7. Bore to size
    a. Check size with a telescoping gage
8. Chamfer
9. Reverse ends
10. Face to length
11. Chamfer all edges
12. Drill with tap drill
13. Tap

MACHINE SHOP

PROJECT #43

TAPER PLUG GAGE

379

TAPER PLUG GAGE

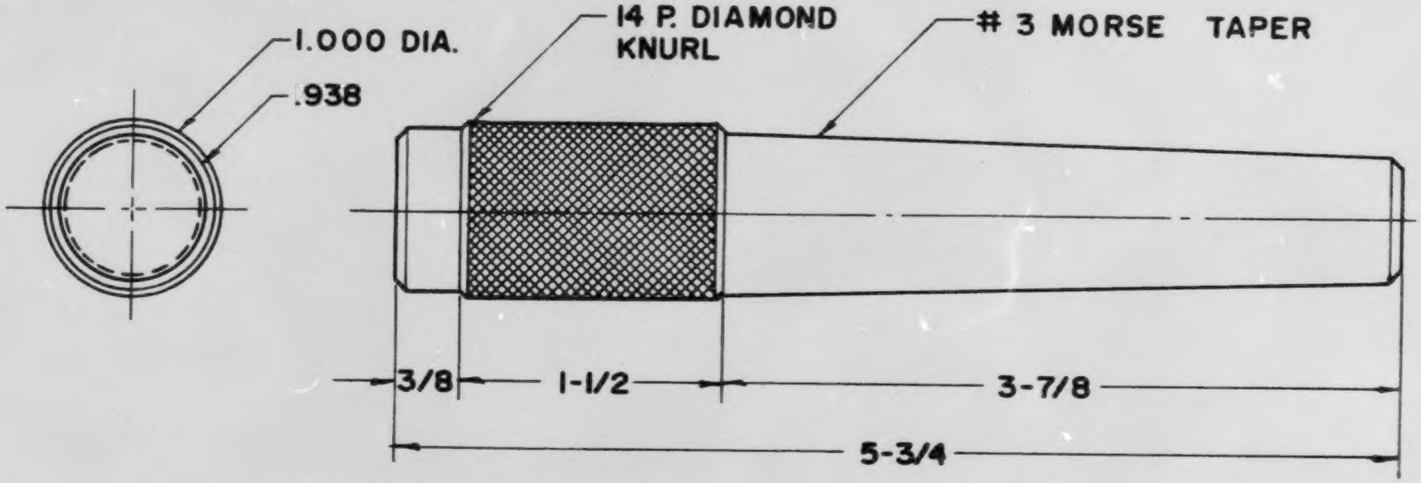
PROJECT #43

COURSES: Measuring, Layout, Lathe

MATERIALS: One Each - Cold Rolled Round 1" diameter x 6" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
M - 2	Measuring with a shoulder or step
L - 3	Grinding a turning tool
L - 9	Turning in a lathe
L - 29	Cutting a taper with the taper attachment
L/O - 1	Using layout tables
L/O - 4	Using a surface gage
L/O - 5	Using layout blue
L - 14	Turn a shoulder on a lathe
M - 3	Measuring with short length rule and holder
L - 15	Knurling on a lathe
L - 18	Polishing in a lathe
L - 13	Working between centers


1.000 DIA.
.938
14 P. DIAMOND KNURL
# 3 MORSE TAPER
3/8
1-1/2
3-7/8
5-3/4

MATERIAL: 1 EA. COLD ROLLED ROUND 1" DIA. X 6" LONG. TOLERANCES: +- 1/32 · +- .003

NOTE: CHAMFER ALL EDGES 1/16 X 45°

381

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			

TITLE TAPER PLUG GAGE

NO 382

43

TAPER PLUG GAGE

PROJECT #43

PROCEDURES:

1. Check stock size
2. Cut to length
    a. Allow 1/4" for facing
3. Chuck in the lathe
    a. Use a three-jaw chuck
    b. Chuck on 1½"
4. Face
5. Center drill
6. Layout the 3 7/8" length
7. Insert a center
8. Grind a turning tool
9. Turn to length
    a. Straight turn to .938"
10. Turn the taper
    a. Use a taper attachment
    b. Check the taper with a taper ring gage
11. Chamfer all edges
12. Remove from the chuck
13. Layout over all length
    a. Use layout table
    b. Use a surface gage
    c. Use layout blue
14. Layout 3/8" shoulder
15. Remove the chuck from the lathe
16. Insert taper in the spindle

    a. Use a spindle sleeve

17. Face to length
18. Center drill
19. Insert center
20. Turn the shoulder
    a. Check the shoulder length
        (1) Use a short length rule and holder
21. Knurl
22. Chamfer all edges
23. Polish the work
    a. Work between centers

MACHINE SHOP

PROJECT #44

ROCKER DISH

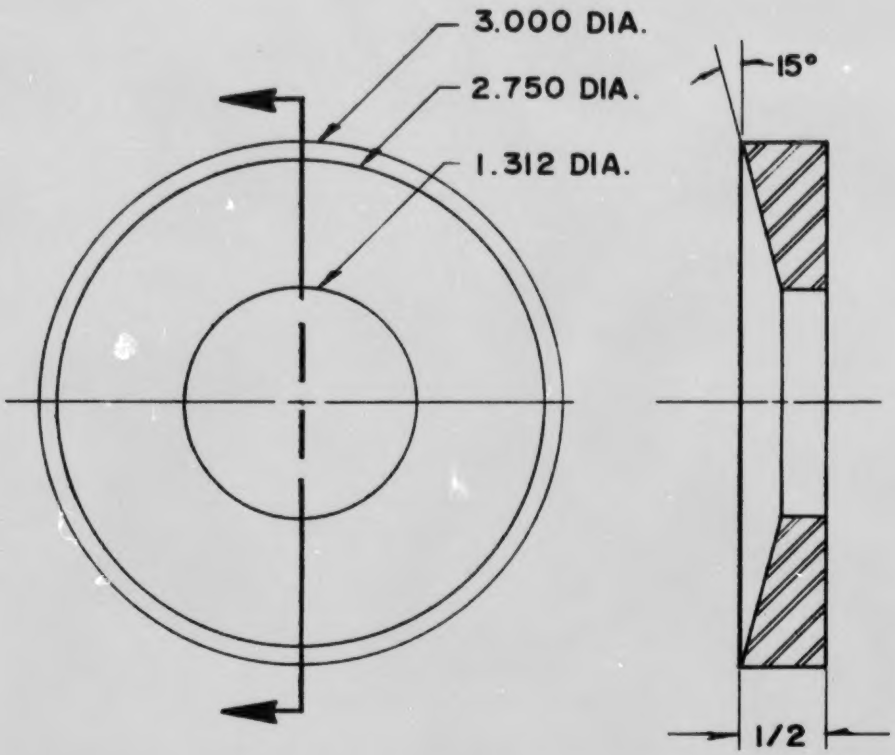
ROCKER DISH

PROJECT #44

COURSES: Measuring, Layout, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 3" diameter x 3/4" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 10	Center drilling in a lathe
	L - 11	Drilling in a lathe
	L - 31	Boring in a lathe
	M - 31	Measuring with an inside micrometer caliper
	L/O - 14	Using hermaphrodite calipers
	M - 37	Measuring with a telescoping gage
	L - 28	Cutting a taper with the compound rest
	L/O - 1	Using layout tables
	L/O - 5	Using layout blue
	L/O - 4	Using a surface gage
	M - 39	Measuring with a vernier bevel protractor


3.000 DIA.
2.750 DIA.
1.312 DIA.
15°
1/2

MATERIAL: CRS ROUND 3 DIA. X 3/4 LONG

TOLERANCES: +- 1/64 · +- .003 · +- 1° = +- .004

387

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			

TITLE
ROCKER DISH

NO
388 44

ROCKER DISH

PROJECT #44

PROCEDURES:

1. Check stock size
2. Cut to length
    a. Allow ¼" for facing
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face
5. Center drill
6. Drill
7. Bore to size
    a. Use an inside micrometer caliper or telescoping gage
8. Layout 1/8" flat
    a. Use a hermaphrodite caliper
9. Cut internal angle
    a. Use the compound rest
10. Chamfer all edges
11. Remove from lathe
12. Layout ½" thickness
    a. Use a layout table
    b. Use layout blue
    c. Use a surface gage
13. Replace in lathe
    a. Line prefaced side parallel to chuck face
14. Face to length
15. Chamfer all edges
16. Check the angle
    a. Use a vernier protractor

MACHINE SHOP

PROJECT #45

ROCKER

ROCKER

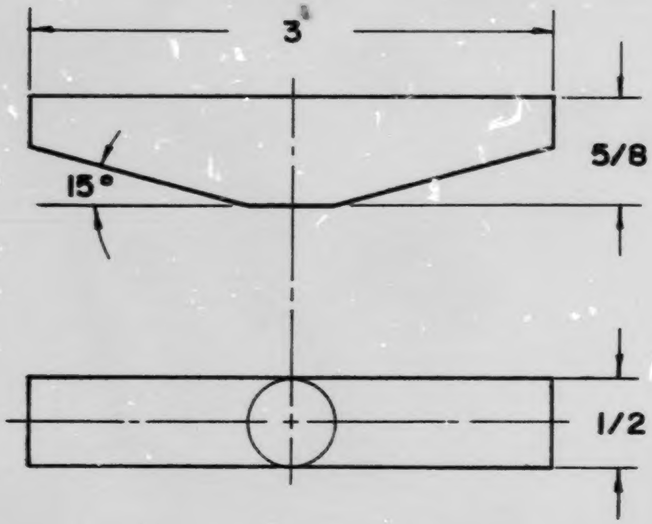
PROJECT #45

COURSES: Measuring, Layout, Lathe

MATERIALS: One Each - Cold Rolled Steel Flat ½" x 3" wide x 7/8" long

TASK:

L/0 - 3	Using a combination set
L - 7	Chucking in a four-jaw chuck
L - 8	Facing in a lathe
L/0 - 11	Using parallels
L/0 - 4	Using a surface gage
L - 28	Cutting a taper with the compound rest
M - 40	Measuring with a sine bar
M - 42	Using a surface plate



MATERIAL: 1 EA. COLD ROLLED STEEL FLAT 1/2 X 3 X 7/8. TOLERANCE: + - 1/32 · + - 1°

392

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD.			
AP'VD			

TITLE ROCKER

NO. 393

ROCKER

PROJECT #45

PROCEDURES:

1. Check stock size
2. Cut 7/8" long
3. Layout a line square to the edge, parallel to the saw cut side
4. Mount in a lathe
    a. Use a four-jaw chuck
5. Face to the line
6. Remove from the lathe
7. Layout the 5/8" height
    a. Use a parallel
    b. Use a surface gage
8. Layout the angles
9. Place in a lathe
    a. Use a four-jaw chuck
    b. Center by using the tailstock
10. Cut the angles
    a. Use the compound rest
11. Chamfer all edges

12. Check angles
    a. Use a sine bar
    b. Use parallels
    c. Use a surface plate

394

MACHINE SHOP

PROJECT #46

TOOL POST BODY

TOOL POST BODY

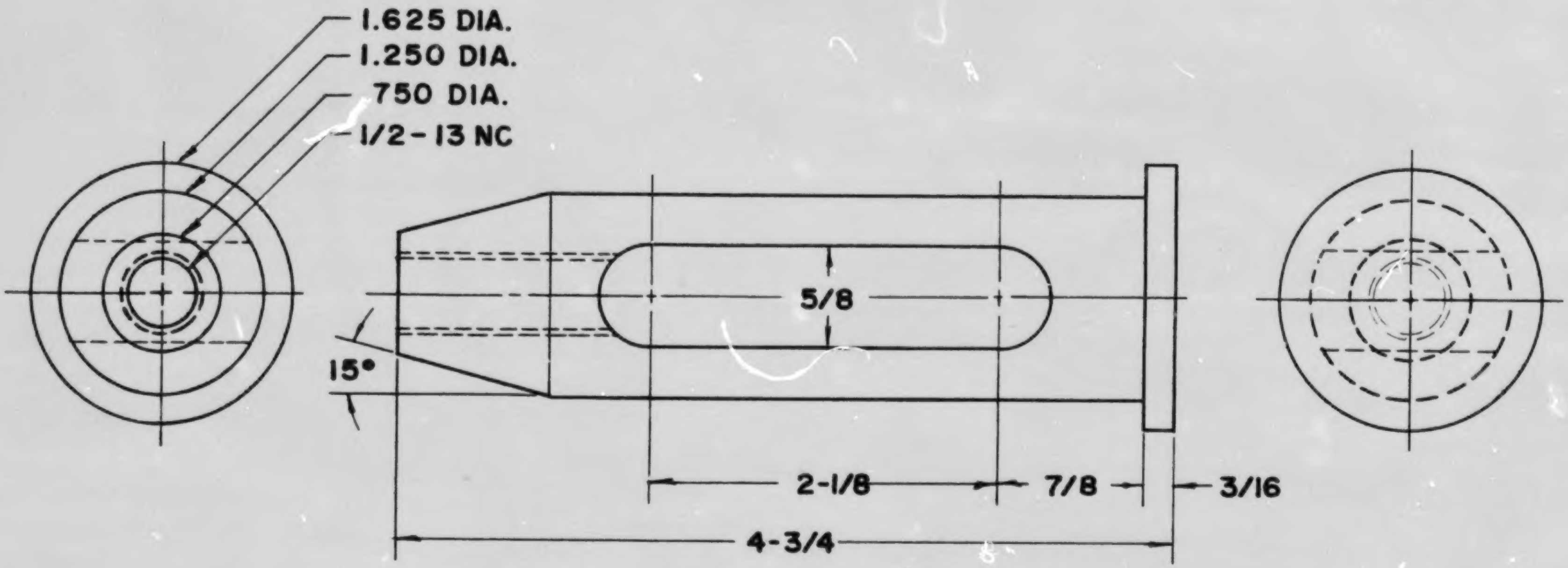
PROJCET #46

COURSES: Measuring, Layout, Lathe, Milling

MATERIALS: One Each - Cold Rolled Steel Round 1 5/8" diameter x 7" long

TASK:

L - 6	Chucking on a three-jaw chuck
L - 8	Facing on a lathe
L - 10	Center drilling on a lathe
L - 2	Grinding a roughing lathe tool
L - 9	Turning in a lathe
L - 28	Cutting a taper with a compound rest
L - 11	Drilling in a lathe
L - 24	Tapping in a lathe
ML - 2	Slot milling on a verticle mill
L/O - 1	Using layout tables
L/O - 13	Using a vernier height gage
L/O - 5	Using layout blue


1.625 DIA.
1.250 DIA.
.750 DIA.
1/2-13 NC
5/8
15°
2-1/8
7/8
3/16
4-3/4

MATERIAL: 1EA. COLD ROLLED STEEL ROUND 1-5/8 DIA. X 7. TOLERANCES: +−1/32· +−.003·+−1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD.			
AP'VD.			

TITLE
TOOL POST BODY

NO. 398

397

TOOL POST BODY

PROJECT #46

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCEDURES:

1. Check stock size
2. Cut to 7" length
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face on the lathe
5. Center drill
6. Insert a center
7. Grind a roughing tool
8. Turn the 1.250" diameter
9. Cut the taper
    a. Use the compound rest
10. Remove the center
11. Drill and tap the hole
    a. Tap 1 3/4" deep
12. Mount on milling machine
13. Mill the slot
14. Cut to length
    a. Allow 1/8" for facing
15. Layout the length
    a. Use a layout table
    b. Use a vernier height gage
    c. Use layout blue
16. Face in a lathe to length

MACHINE SHOP

PROJECT #47

CIRCLE CUTTER

400

CIRCLE CUTTER

PROCJECT #47

COURSES: Measuring, Layout, Bench, Drill Presses, Lathes, Milling Machines

MATERIALS:

One Each - Cold Rolled Square ½" x ½" x 7¼" Long

One Each - Cold Rolled Round 1" diameter x 3½" long

One Each - Cold Rolled flat 3/16" x ½" x 1½" long

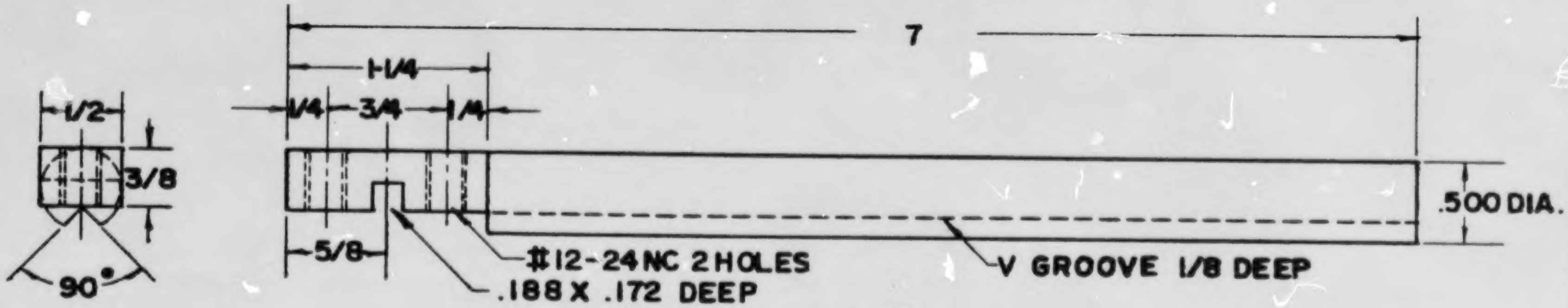
One Each - ¼"-20 Allen Head Set Screws 90° point x ¼" Long

Two Each - #12-24 NC Flat Head Machine Screws 82°

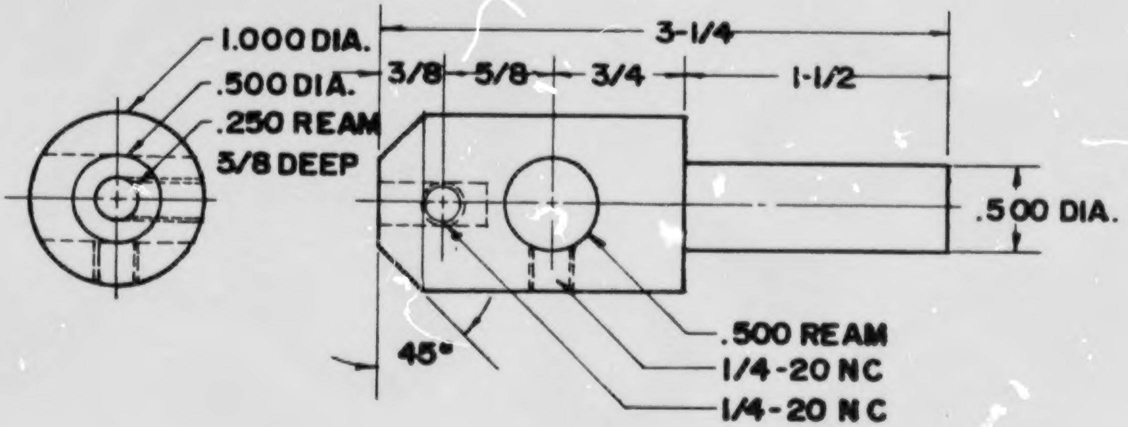
TASK:

M - 9	Measuring with a slide caliper rule
B - 5	Use a hand hacksaw
B - 6	Use a file
L/O - 3	Use a combination set
L/O - 5	Use layout blue
L/O - 2	Use a scriber
L/O - 10	Use an automatic center punch
D - 1	Drilling on a drill press
D - 4	Countersinking on a drill press
L - 7	Chucking in a four-jaw chuck
M - 41	Using a dial indicator
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 28	Cutting a taper with the compound rest
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
L - 9	Turning in a lathe

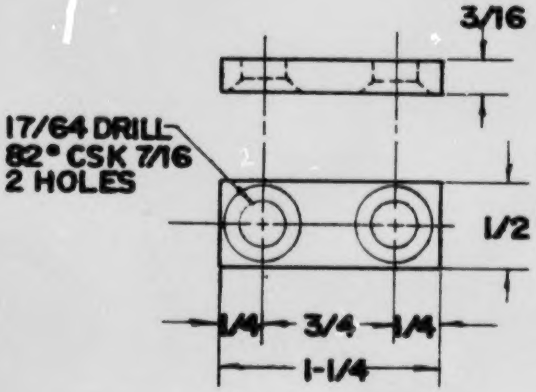
D - 2	Reaming on a drill press
D - 7	Tapping on a drill press
L - 6	Chucking in a three-jaw chuck
ML - 5	End milling
ML - 2	Slot milling on a verticle mill
ML - 8	Angle milling on a horizontal mill


7
1-1/4
1/2
1/4
3/4
1/4
3/8
.500 DIA.
90°
5/8
#12-24 NC 2 HOLES
.188 X .172 DEEP
V GROOVE 1/8 DEEP

BAR ①


1.000 DIA.
.500 DIA.
.250 REAM
5/8 DEEP
3-1/4
3/8
5/8
3/4
1-1/2
.500 DIA.
45°
.500 REAM
1/4-20 NC
1/4-20 NC

BODY ②


3/16
17/64 DRILL
82° CSK 7/16
2 HOLES
1/2
1/4
3/4
1/4
1-1/4

TOOL PLATE ③

TOLERANCES: ±1/32 · ±.003 ± 1°

5	2	12-24 NC FLAT HEAD MACHINE SCREWS	
4	1	1/4-20 ALLEN HEAD SET SCREW X 1/4"	90° PT.
3	1	FLAT 3/16 X 1/2 X 1-1/2	CRS
2	1	1 DIA. X 3-1/2	CRS
1	1	SQUARE 1/2 X 7-1/4	CRS
NO.	REQ	NAME AND OR SIZE	MA

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD			
AP'VD			

TITLE CIRCLE CUTTER

NO 04

47

403

CIRCLE CUTTER

PROJECT #47

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCEURES: Tool Plate

1. Measure stock size
   a. Use a slide caliper rule
2. Cut to length
   a. Use a hand hacksaw
   b. File square and chamfer edges
3. Layout hole locations
   a. Use a combination set
   b. Layout blue
   c. Scriber
4. Center punch hole locations
   a. Use an automatic center punch
5. Set up in a drill press
6. Drill
7. Countersink
8. Remove all burs

Body

9. Check stock size
10. Cut to length
    a. Allow ¼" for facing
11. Chuck in a lathe
    a. Use a four-jaw chuck

405

    b. True the stock
        (1) Use a dial indicator
12. Face one end
13. Center drill
14. Insert a center
15. Cut the 45° angle
    a. Use the compound rest
16. Remove the center
17. Drill and ream the .250 hole
18. Reverse ends
    a. Layout length
19. Dial indicate true
20. Face to length
21. Center drill
22. Insert a center
23. Turn to .500
24. Chamfer
25. Remove from lathe
26. Layout the reamed and tapped holes
27. Drill and ream
    a. Use a drill press
28. Drill and tap
    a. Use a drill press
29. Remove all burs and layout blue

Bar

30. Check stock size
    a. Use a vernier caliper

31. Cut to length 7¼"
32. Chuck in a lathe
    a. Chuck in a four-jaw chuck
    b. Have ½" extending from the chuck
    c. True the stock
33. Face the stock
34. Center drill
35. Loosen two jaws and bring the stock out until 6" is extending out of the jaw
36. Tighten the same two jaws
37. Insert a center
38. Re-indicate at the chuck
39. Turn the .500" diameter
    a. Chamfer all edges
40. Remove from the lathe
41. Layout the length
42. Chuck in a lathe
    a. Use a three-jaw chuck
43. Face to length
    a. Chamfer all edges
44. Place on a vertical mill
45. Mill flat surface
    a. Use an end mill
46. Mill the slot
    a. Use an end mill
47. Place part on a horizontal mill
48. Mill groove
    a. Use an angle cutter

49. Drill and tap holes

    a. Use a drill press

50. Remove all burs

51. Assemble

408

MACHINE SHOP

PROJECT #48

SAW JIG I

SAW JIG I

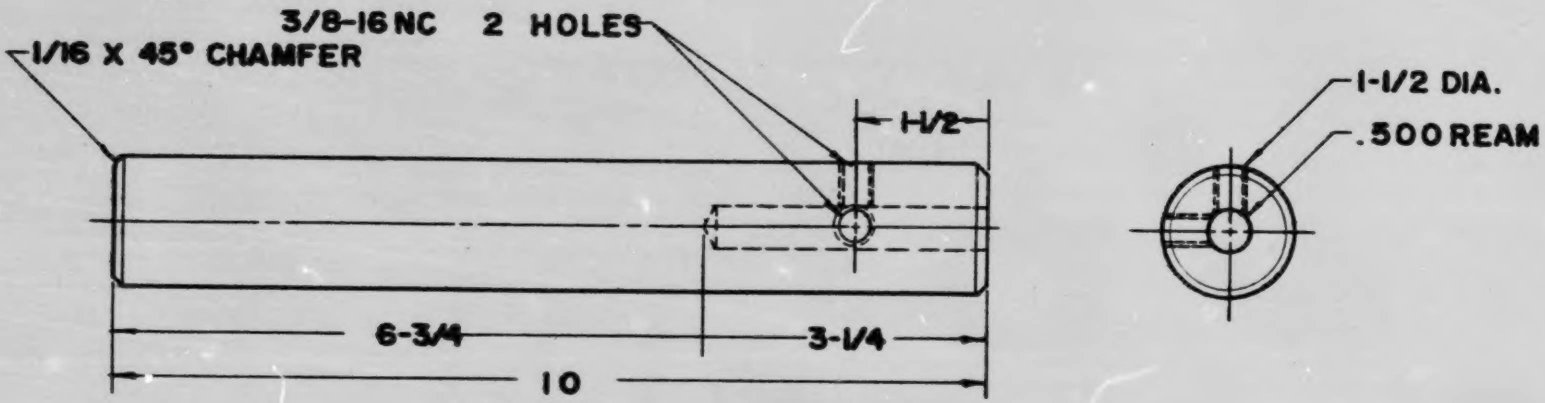
PROJECT #48

COURSES: Measuring, Bench Work, Drill Presses, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 1½" diameter x 10¼" long

Two Each - 3/8"-16 NC Allen Head Set Screws 3/8" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 33	Using a steady rest on a lathe
	L - 8	Facing in a lathe
	L - 10	Center drilling in a lathe
	L - 11	Drilling in a lathe
	L - 12	Reaming in a lathe
	M - 36	Measuring with a small hole gage
	M - 30	Measuring with an outside micrometer caliper
	M - 35	Measuring with a vernier height gage
	D - 1	Drilling on a drill press
	D - 7	Tapping on a drill press
	B - 9	Use a hand reamer
	B - 12	Use a letter and/or number punch set


3/8-16NC 2 HOLES
1/16 X 45° CHAMFER
1-1/2
1-1/2 DIA.
.500 REAM
6-3/4
3-1/4
10

MATERIALS: 1 EA. CRS ROUND 1-1/2 DIA. X 10-1/4
2 EA 3/8-16NC X 3/8 ALLEN HD. SET
SCREWS.

SCALE 1/2 SIZE	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD.			
AP'VD.			
TITLE SAW JIG (FLY CUTTER)	NO. 412 48		

411

SAW JIG I

PROJECT #48

PROCEDURES:

1. Check stock size
2. Cut to length 10⅛"
3. Mount in a lathe
   a. Use a three-jaw chuck
   b. Use a steady rest
4. Face
5. Center drill
6. Drill with a pilot drill
7. Drill
8. Ream
9. Chamfer edges
10. Check the hole size
    a. Use a small hole gage
    b. Use a micrometer
11. Reverse ends
12. Face to length
13. Chamfer
14. Layout the holes to be tapped
    a. Use a vernier height gage
15. Drill and tap the holes
    a. Use a ½" hand reamer to de-bur the inside of the hole
16. Number with a punch set

REFERENCES

1. Krar, S. F. and Oswald, J. W.: Grinding Technology. Albany: Delmar Publishers, 1974.

2. Lascoe, Nelson, Porter: Machine Shop - Operations and Setups. Chicago: American Technical Society, 1973

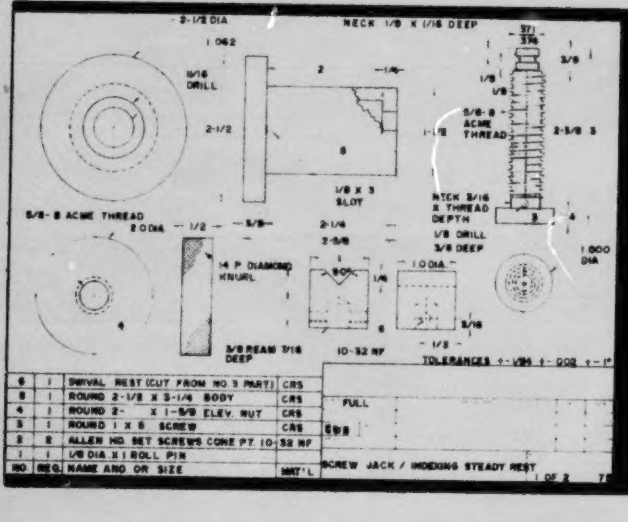
3. Oberg, Erik and Jones, F. D.: Machinery's Handbook. New York, N.Y.: Industrial Press Inc., 1976

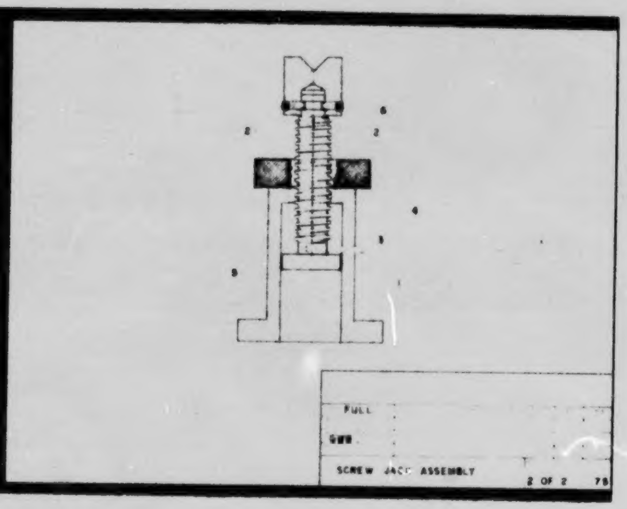
4. Morse: Machinist's Practical Guide. New Bedford, Mass: Morse Cutting Tools Division, 1978

5. Krar, S.F.; Oswald, J. W. and St. Amond, J. E.: Technology of Machine Tools. New York: McGraw-Hill Book Company, Gregg Division, 1977

MACHINE SHOP PROJECTS

LATHE, MILLING MACHINES
Projects 49-61


2-1/2 DIA
NECK 1/8 X 1/16 DEEP
1.062
11/16 DRILL
2
2-1/2
1/8 X 3 SLOT
5/8-8 ACME THREAD
NECK 3/16 X THREAD DEPTH
1/8 DRILL
3/8 DEEP
2-3/8
5/8-8 ACME THREAD
2 DIA
1/2
2-1/4
2-5/8
1 DIA
1.600 DIA
14 P DIAMOND KNURL
90°
3/8 REAM 7/16 DEEP
10-32 NF
1/2
3/16
TOLERANCES
6 | 1 | SWIVAL REST (CUT FROM NO 3 PART) | CRS
5 | 1 | ROUND 2-1/2 X 3-1/4 BODY | CRS
4 | 1 | ROUND 2- X 1-5/8 ELEV. NUT | CRS
3 | 1 | ROUND 1 X 5 SCREW | CRS
2 | 2 | ALLEN HD. SET SCREWS CONE PT 10-32 NF
1 | 1 | 1/8 DIA X 1 ROLL PIN
NO. | REQ. | NAME AND OR SIZE | MAT'L
FULL
SCREW JACK / INDEXING STEADY REST
1 OF 2


6
2
2
4
3
5
FULL
SCREW JACK ASSEMBLY
2 OF 2

STUDENT MANUAL

Georgia Department of Education

MACHINE SHOP PROJECTS

Developed Under a Grant from

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1980

This project was developed under a grant from:

Division of Program Development
Office of Vocational Education
Georgia Department of Education

Project Numbers: 98251 and 28252

to:

Augusta Area Vocational-Technical School

Author:
Raymond E. Westbrook
Instructor, Machine Shop

Drawings:
George W. Baggs, Jr.
Instructor, Drafting and Design

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Part B: PROJECT LISTING (Categorized)

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Project Drawings
Fabrication Procedures

Part D: REFERENCES

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PURPOSE

A student in Machine Shop must learn by doing. Although lectures, reading assignments, and audio-visual aids are very necessary, these methods alone will never produce a good machinist. The combination of both classroom and shop practice is essential to your training. The purpose of this Shop Project Guide is to give the necessary shop experience to complement your classroom training. This guide is based on the author's years of practical experience as a skilled machinist and as a teacher in the field. Each skill needed to complete a phase of your training has been identified. Next, projects have been devised to give hands-on experience for each skill with enough repetition so that you will become capable of using each tool or attachment for the particular machine or operation being taught. Your instructor will help you select or will assign the projects in the necessary order. You will also find the end products of these projects will be useful tools that will help in your training that follows. This serves not only to make the projects more interesting, but more enjoyable to construct. This practical training along with classroom instruction and applied learning can bring you a rewarding future as a skilled tradesman.

PROJECT LISTING (CATEGORIZED)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench
*11. Pipe flange assembly
*12. C-clamp
*13. Block and tackle
*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects
*16. Jack Stand
*17. Gear puller
18. Tool post base

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MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (genreal purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. 1/4" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
40. Dead center
41. Plumb bob

42. Dumbbell set

43. Taper plug gage

44. Rocker dish

45. Rocker

46. Tool post body

47. Circle cutter

48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II

*50. Fly cutter

51. Tooth pick holder

*52. Pipe center

53. Taper ring gage

54. Set up bolt 1/2" x 4"

55. Set up bolt 1/2" x 6"

56. Set up bolt 1/2" x 8"

57. Set up bolt 3/8" x 4"

58. Set up bolt 3/8" x 6"

59. Drill reducer

60. Tap drill extension (1/4" - 20 NC tap drill)

61. Tap drill extension (5/16" - 18 NC tap drill)

62. Boring bar holder body jig

63. Boring bar holder body

*64. Boring bar holder base

65. Boring bar holder inner body

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66. Boring bar holder base jig

67. Precision measuring tool block

*68. Milling arbor #40 - 3/8"

*69. Milling arbor #40 - 1/5"

*70. Milling arbor #40 - 5/8"

*71. Milling arbor #40 - 3/4"

*72. Lathe arbor

73. Mallet

74. Acme thread/boring tool

*75. Screw jack/indexing steady rest

76. Lathe chuck wrench

77. Internal pipe wrench

78. Buffer/grinder shaft

SHAPER

79. Splitting wedge

80. Flat strap clamp

*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks I

*83. V-blocks

84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge

86. Solid key seat

87. Water valve wrench

88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. 1/4" pitch, 1' lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

MACHINE SHOP

PROJECT #49

TAP WRENCH II

425

TAP WRENCH II

PROJECT #49

COURSES: Measuring, Layout Work, Bench Work, Saws, Drill Presses, Lathe, Shapers

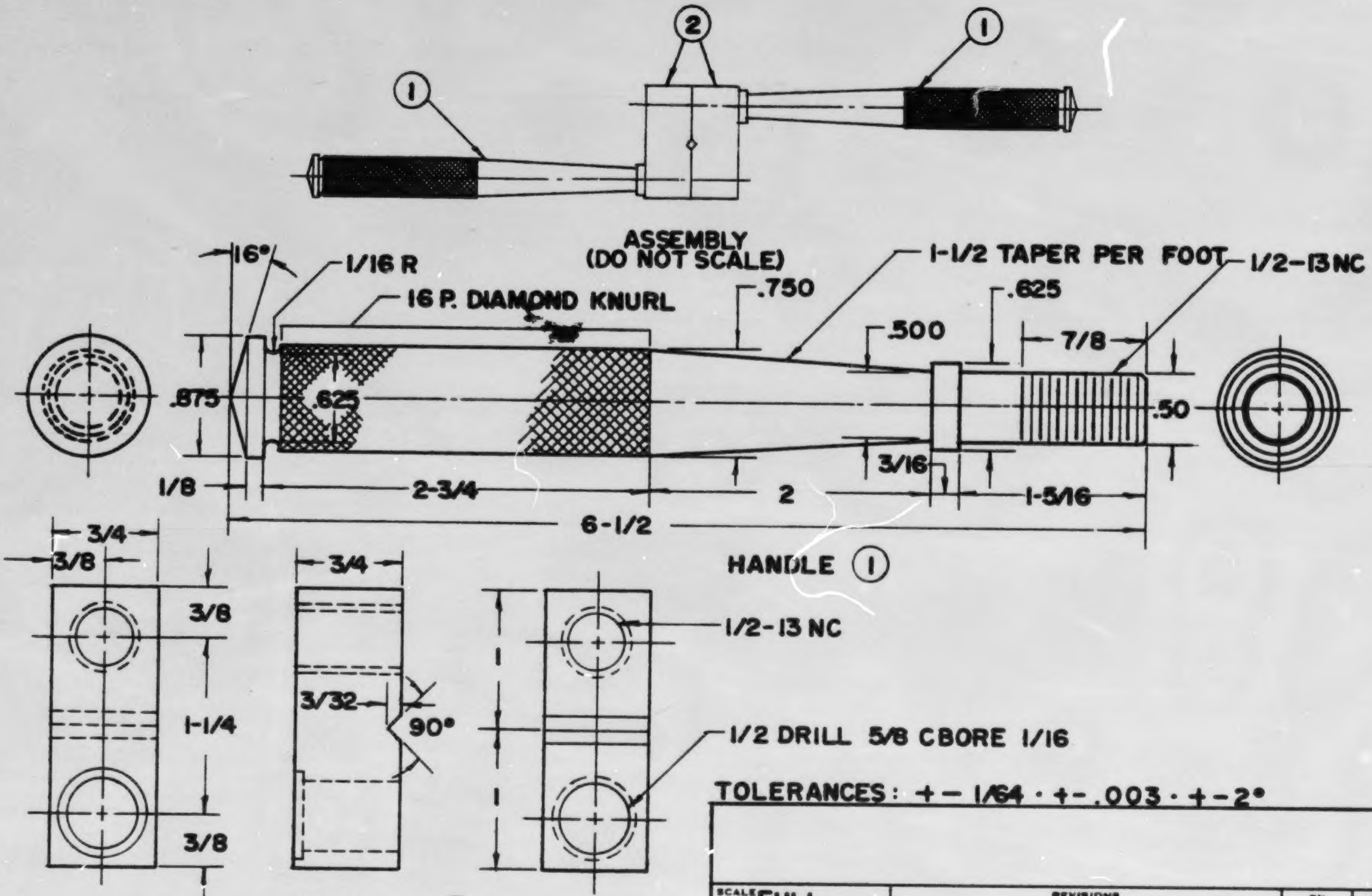
MATERIALS: Two each - Cold Rolled Steel Round 7/8" diameter x 8" long

Two each - Cold Rolled Steel Square 3/4" x 3/4" x 2 1/4" long

TASK:

M - 34	Measuring with a vernier caliper
S - 1	Cutting to length on a horizontal band or power hacksaw
B - 6	Using a file
L/O - 1	Using layout tables
L/O - 5	Using layout blue
M - 1	Measuring with a steel rule
L/O - 4	Using a surface gage
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press
D - 5	Counterboring on a drill press
SP - 1	Trueing a vice in a shaper
L/O - 11	Using parallels
SP - 5	Grinding a shaper tool
G - 1	Dressing the wheel for grinding
G - 2	Off-hand grinding
L - 6	Chucking in a three-haw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 9	Turning in a lathe
L - 29	Cutting a taper with the taper attachment

L - 22	Cutting external V-threads in a lathe
L - 36	Cutting a radius in a lathe
L - 15	Knurling on a lathe
L - 28	Cutting a taper with the compound rest



2
1
1
16°
1/16 R
16 P. DIAMOND KNURL
.750
1-1/2 TAPER PER FOOT
1/2-13NC
.625
.500
7/8
.875
.625
.50
3/16
1/8
2-3/4
2
1-5/16
6-1/2
3/4
3/8
3/8
1-1/4
3/8
3/4
3/32
90°
1/2-13 NC
1/2 DRILL 5/8 CBORE 1/16

ASSEMBLY
(DO NOT SCALE)

HANDLE ①

TAP BLOCK ②

TOLERANCES: +- 1/64 · +-.003 · +-2°

2	2	3/4 X 3/4 X 2-1/4 SQUARE	CRS
1	2	7/8 DIA. X 8 ROUND	CRS
NO.	REQ	NAME AND OR SIZE	MAT.

SCALE FULL
DATE
DR'N GWB
CKD
AP'VD

REVISIONS	BY	DATE

TITLE TAP WRENCH II

NO. 49

BRUNING 40-105

4

TAP WRENCH II

PORJECT #49

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCEDURES: Tap Blocks

1. Check the stock size
    a. Use a vernier caliper
2. Cut and file to length
    a. Use a horizontal band or power hasksaw
    b. Use a file
3. Layout the holes and angle
    a. Use a layout plate
    b. Use a layout blue
    c. Use a steel rule
    d. Use a surface gage
4. Drill, tap, and counterbore the holes
    a. Use a drill press
5. Cut the slot
    a. Use a shaper
    b. True the vice
    c. Use parallels
    d. Grind a shaper tool
        (1) Use a bench grinder
        (2) Dress the wheel
6. Chamfer all edges

Handles

7. Check stock size
8. Cut 8" long
9. Chuck in a lathe
    a. Use a three-jaw chuck
    b. Have ½" extending from the lathe
10. Face and center drill
11. Loosen chuck
    a. Pull the stock out
    b. Have 1¼" in the chuck
    c. Re-chuck
12. Turn the .750" diameter
13. Turn the .625" diameter
14. Turn the .500" diameter
15. Cut the taper
    a. Use a taper attachment
16. Cut the threads
    a. Use a die stock
17. Cut the radius
18. Knurl
19. Cut the stock
    a. Allow 1/8" for facing
20. Face to length
21. Cut the 16° angel
    a. Use the compound rest
22. De-bur all edges
23. Assemble

MACHINE SHOP

PROJECT #50

FLY-CUTTER

FLY CUTTER

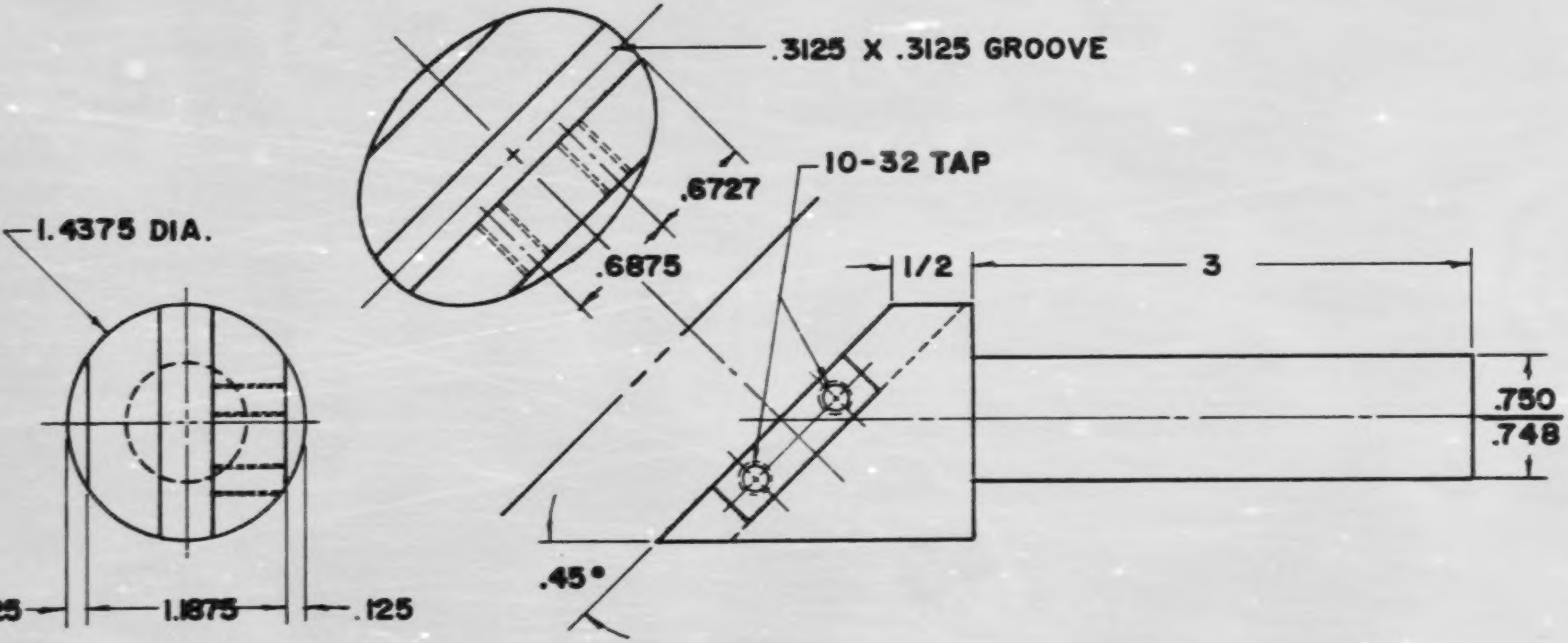
PROJECT #50

COURSES: Measuring, Saws, Lathe, Milling

MATERIALS: One Each - Hot Rolled Steel Round 1½" diameter x 6" long

TASK;

S - 1	Cutting to lenth on a horizontal band or power hacksaw
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling on a lathe
L - 9	Turning in a lathe
L - 14	Turning a shoulder on a lathe
S - 2	Cutting an angle on a horizontal band saw
ML - 1	Aligning a vice on a mill
ML - 4	Face milling
ML - 7	Angle milling on a verticle mill
ML - 6	Fly cutter milling
ML - 5	End milling
ML - 2	Slot milling on a verticle mill
M - 36	Measuring with a small hole gage
M - 33	Measuring with a micrometer depth gage


.3125 X .3125 GROOVE
10-32 TAP
.6727
.6875
1.4375 DIA.
1/2
3
.750
.748
.45°
.125
1.1875
.125

UNLESS OTHERWISE SPECIFIED TOLERANCES TO BE:
+ − 1/64 · + − .002 · = + − .001 · + − 1°

MATERIAL: 1 EA. HRS ROUND 1-1/2 X 6

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AP'VD.			

TITLE
FLY CUTTER

NO.
435

50

BRUNING 40-105

FLY-CUTTER

PROJECT #50

SPECIAL INSTRUCTIONS: Part of this project requires basic Machine Shop skills while other parts will require more advanced skills.

This project may require the use of Project #48 (Saw Jig).

PROCEDURES:

1. Check the stock
2. Cut to length 6" long
3. Chuck in a lathe
   a. Use a three-jaw chuck
4. Face one end
5. Center drill
6. Use a center
7. Turn the 1.437" diameter 5 1/8" long
8. Turn the .750" diameter
9. Remove from the lathe
10. Mount in the saw jig
11. Set the horizontal band saw to cut 45°
12. Cut to length
    a. Allow 1/8" for facing
13. Set-up in a vertical mill
    a. Use V-blocks
    b. Use a vice
       (1) True the vice
    c. Be sure the head is square
    d. Use a protractor with a level
14. Face the 45° surface to length
    a. Use a fly-cutter
15. Find the edge of one side

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    a. Use a 5/16" end mill
    b. Zero the machine
16. Mill the flat on one side
    a. Use the micrometer collar
17. Mill the slot
    a. Use the micrometer collar
18. Mill the second flat on the side
    a. Use the micrometer collar
19. Layout the holes on the flat
20. Drill and tap the holes
21. De-bur all edges
22. Check the depth width of the slot
    a. Use a small hole gage
    b. Use a micrometer depth gage

MACHINE SHOP

PROJECT #51

TOOTH PICK HOLDER (TURRET LATHE)

TOOTH PICK HOLDER (TURRET LATHE)

PROJECT #51

COURSES: Measuring, Lathe (Turret), Grinding

MATERIALS: One Each - Aluminum Round 6061 T-6 or 7075 T-6 1" diameter x 3" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 37	Chucking in a collet chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 9	Turning in a lathe
G - 1	Dressing the wheel for grinding
G - 2	Off-hand grinding
G - 3	Grinding an angle on a tool and cutter grinder
M - 37	Measuring with a telescoping gage
M - 30	Measuring with an outside micrometer caliper
M - 8	Measuring with a rule depth gage
L - 36	Cutting a radius in a lathe
L - 18	Polishing in a lathe
L - 20	Honing in a lathe
L - 16	Cutting off in a lathe
M - 42	Using a surface plate
M - 35	Measuring with a vernier height gage

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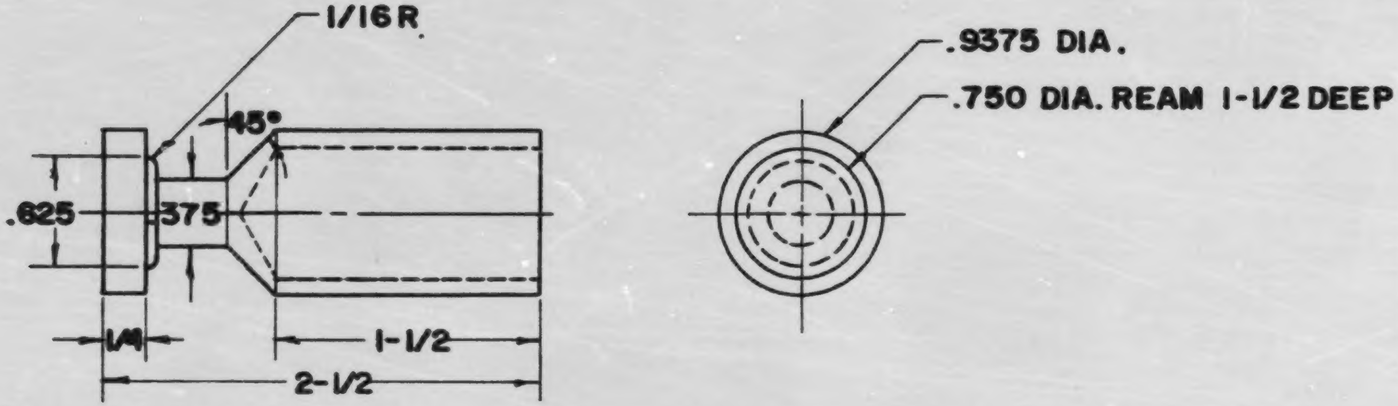
1/16R.
45°
.625
.375
1/4
1-1/2
2-1/2
.9375 DIA.
.750 DIA. REAM 1-1/2 DEEP

MATERIAL: 1 EA. ALUMINUM ROUND 6061-T6 OR 7075 T6. 1 DIA. X 3. TOLERANCES: +-1/64 · +-.002 · +-1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD			
AP'VD.			

TITLE
TOOTH PICK HOLDER

NO.
441

51

440

BRUNING 40-105

TOOTH PICK HOLDER (TURRET LATHE)

PROJECT #51

SPECIAL INSTRUCTIONS: This project was designed for operation of a turret lathe.

Complete polishing procedures may be followed at this time.

PROCEDURES:

1. Check stock size
2. Set stock stop
    - a. Have at least 3" extending from chuck
    - b. A three-jaw or collet chuck may be used
3. Face the stock
4. Center drill the stock
    - a. Insert center
5. Turn the stock .9375"
6. Cut the angle, turn .375" diameter form radius and face base
    - a. All these may be done with one form ground tool
        - (1) Use a bench grinder or a tool and cutter grinder
7. Drill and ream
    - a. Check with a telescoping gage and micrometer
    - b. Check with a rule depth gage
8. Use a form ground radius tool and round the top lip
    - a. Use a bench grinder or tool and cutter grinder
9. Polish
    - a. Use all paper wet
        - (1) Kerosene
          (or)
        - (2) Mineral spirits

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  - b. Start with 180 grit
  - c. 240 grit
  - d. 300 grit
  - e. 400 grit
  - f. 600 grit
  - g. Red rouge
    - (1) Use on a clean wet soft cloth
  - h. Use each grit emery until all acratches have been reduced to the same size

10. Hone the hole

11. Cut off with a cut off tool
    - a. When cut is half through chamfer with emery paper

12. Check height with a vernier height gage and surface plate

MACHINE SHOP

PROJECT #52

PIPE CENTER

19 444

PIPE CENTER

PROJECT #52

COURSES: Measuring, Layout, Bench Work, Drill Presses, Lathe, Mill

MATERIALS: One Each - Cold Rolled Steel Round 1½" diameter x 5 5/8" long

One Each - Hot Rolled Steel Round 2" diameter x 2¼" long

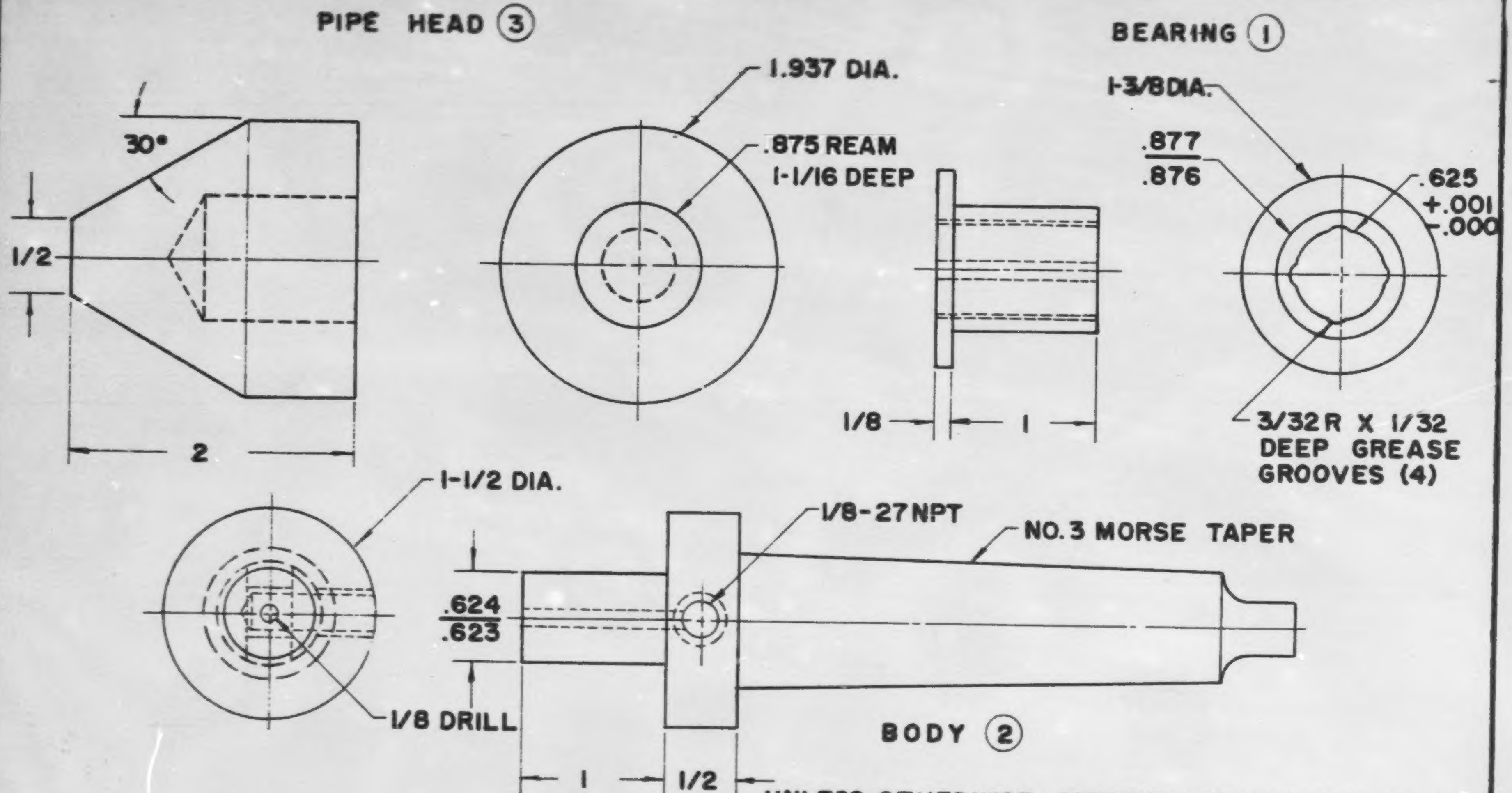
One Each - Brass Free Machining 1 3/8" x 2½" long

One Each - 1/8 - 27 Grease Fitting

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 28	Cutting a taper with the compound rest
L/O - 13	Using a vernier height gage
L/O - 1	Using layout tables
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
L - 7	Chucking in a four-jaw chuck
M - 41	Using a dial indicator
L - 14	Turning a shoulder on a lathe
L - 10	Center drilling in a lathe
M - 37	Measuring with a telescoping gage
L - 9	Turning in a lathe
L - 3	Grind a turning tool
M - 18	Measuring with a radius and fillet gage
L - 20	Honing in a lathe
L - 16	Cutting off in a lathe
L - 13	Working between centers
L - 30	Cutting the taper by off-setting the tailstock

L - 18	Polishing in a lathe
ML - 14	Indexing on a mill
ML - 5	End milling
B - 10	Use an arbor press
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press


PIPE HEAD ③
BEARING ①
1.937 DIA.
1-3/8 DIA.
30°
.875 REAM
1-1/16 DEEP
.877
.876
.625
+.001
-.000
1/2
2
1/8
1
3/32 R X 1/32
DEEP GREASE
GROOVES (4)
1-1/2 DIA.
1/8-27 NPT
NO. 3 MORSE TAPER
.624
.623
1/8 DRILL
BODY ②
1
1/2

UNLESS OTHERWISE SPECIFED TOLERANCES SHALL BE: +-1/64 · +-.002 · +-1°

NO.	REQ.	NAME AND OR SIZE	MAT.
4	1	1/8-27 GREASE FITTING (NOT SHOWN)	
3	1	2 DIA. X 2-1/4	HRS
2	1	1-1/2 DIA. X 5-5/8	CRS
1	1	1-3/8 DIA X 2-1/2 FREE MACHINING BRASS	

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TITLE
PIPE CENTER

NO
52

447

BRUNING 40-105

PIPE CENTER

PROJECT #52

SPECIAL INSTRUCTIONS: Part of this project will require basic Machine Shop skills while others will require more advanced skills.

See machinist practical guide for allowances of fits and taper information.

PROCEDURES: Pipe Head

1. Check stock size
2. Cut to 2¼" length
3. Chuck in a three-jaw chuck
    a. Have 1½" out of the lathe
4. Face
    a. DO NOT CENTER DRILL
5. Cut the taper
    a. Use a compound rest
    b. Rough to 5/8" at the point
        (1) NOT ½"
6. Remove from chuck
7. Layout the height
    a. Use a vernier height gage
    b. Use a layout table
8. Re-chuck and face to length
9. Drill and ream the .875 hole

Bearing

10. Check stock size
11. Chuck stock in a lathe
    a. Use a four-jaw chuck

    - b. Have 1½" out of the chuck
12. Indicate stock
    - a. Use a dial indicator
13. Face
14. Turn shoulder 1" long
    - a. Turn to .900"
15. Center drill
16. Ream
    - a. Check hole size with a telescoping gage
17. Finish turn the outside diameter (OD)
    - a. Grind a turning tool
18. Chamfer edge of .875" about ¼" long with a file
    - a. This will help in press
19. Cut the grease grooves
    - a. Grind a 3/16" tool
        - (1) Use a radius gage
    - b. Insert in a boring bar
        - (1) Cutting edge vertical
    - c. Drag the tool out with the carriage
        - (1) Lock the chuck
            - (a) Use lowest speed
            - (b) DO NOT turn the machine on
    - d. Use the cross slide micrometer collar to get depth
        - (1) Take only .003" - .005" per cut
20. Hone
    - a. Use a sand paper hone
21. Cut to length
    - a. Use a cut-off tool

Body

22. Check the stock size
23. Cut to 5 5/8" long
24. Face and center drill
25. Layout length
    a. Use a vernier height gage
    b. Use a layout plate
26. Face to length
27. Center drill
    a. Center drill to 1/4" diameter
        (1) Use a #3 Center drill
28. Set up between centers
    a. Place small center drill hole on tailstock center
29. Cut taper
    a. Off-set tailstock center
30. Reverse on centers
    a. Align centers
31. Cut 5/8" diameter
    a. Face shoulder
    b. Polish
32. Remove from lathe
33. Place on vertical mill
    a. Use a dividing head
        (1) Between Center
    b. Use an end mill
34. Mill tang
35. De-bur all parts

Assembly

36. Press bearing in pipe head

    a. Use lubricant
    b. Be sure hole in pipe body is chamfered
    c. Use an arbor press

37. Mount body in spindle of lathe
    a. Remove chuck
    b. Use sleeve
    c. Check true of 5/8" diameter
        (1) Use a dial indicator
38. Mount bearing and head assembly on 5/8" shaft
39. Center drill pipe head
40. Insert center
    a. Apply slight pressure
41. Finish cut the taper to ½"
    a. Use the compound rest
    b. This will true the center with the taper
42. Remove head assembly and drill 1/8" hole
43. Drill and tap for the grease fitting
    a. Use a drill press

MACHINE SHOP

PROJECT #53

TAPER RING GAGE
(#3 MORSE TAPER)

453

TAPER RING GAGE
# (#3 MORSE TAPER)

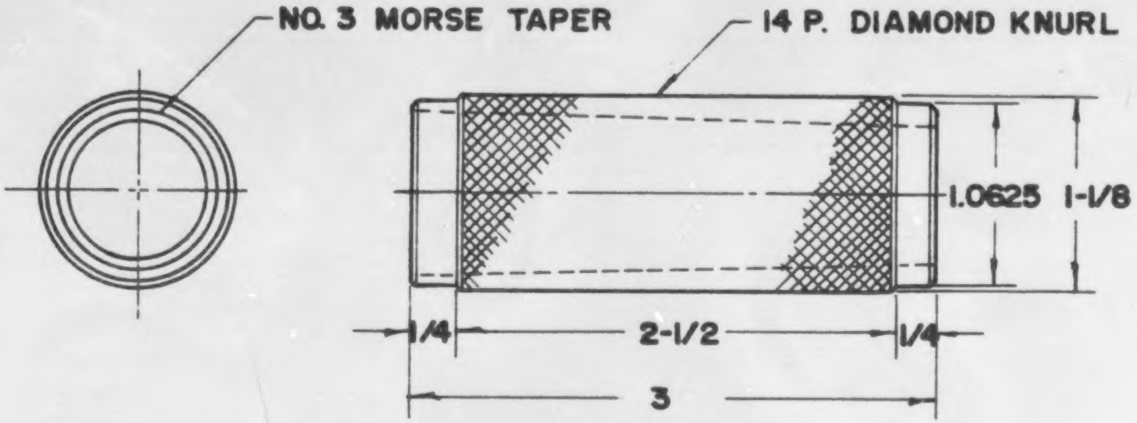
PROJECT #53

COURSES: Measuring, Bench Work, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 1 1/8" diameter x 5" long

TASK:

L - 7	Chucking in a four-jaw chuck
M - 41	Using a dial indicator
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 9	Turning in a lathe
L - 5	Grinding a necking tool
L - 15	Knurling on a lathe
L - 11	Drilling in a lathe
L - 29	Cutting a taper with the taper attachment
L - 31	Boring in a lathe
B - 9	Using a hand reamer
L - 16	Cutting off in a lathe


NO. 3 MORSE TAPER
14 P. DIAMOND KNURL
1.0625
1-1/8
1/4
2-1/2
1/4
3

NOTE: CHAMFER ALL CORNERS
1/32 X 45°

MATERIAL: 1 EA. CRS ROUND 1-1/8 X 5

TOLERANCES: +- 1/64 · +-.002

SCALE FULL		REVISIONS	BY	DATE
DATE				
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AP'VD				
TITLE TAPER RING GAGE (NO. 3 MORSE)			NO. 456	

455

BRUNING 40-105

TAPER RING GAGE
(#3 MORSE TAPER)

PROJECT #53

PROCEDURES:

1. Check stock
2. Cut to 5" long
3. Chuck in a lathe
   a. Chuck in a four-jaw chuck
   b. Indicate
   c. Have 3½" extending from the chuck
4. Face one end
5. Center drill
6. Insert center
7. Turn the 1 1/16" diameter
8. Grind a necking tool
9. Neck the other end to the 1 1/16" diameter
10. Knurl
11. Remove the center
12. Drill
    a. Use a 3/4" drill
13. Set up taper attachment
14. Bore the tapered hole
15. Hand ream the taper
    a. Use a #3 morse taper hand finishing reamer
16. Chamfer all edges
17. Cut off to length
    a. Use a cut-off tool

MACHINE SHOP

PROJECT #54

SET-UP BOLTS
(1/2" x 4" Long)

SET-UP BOLTS
(1/2" x 4" Long)

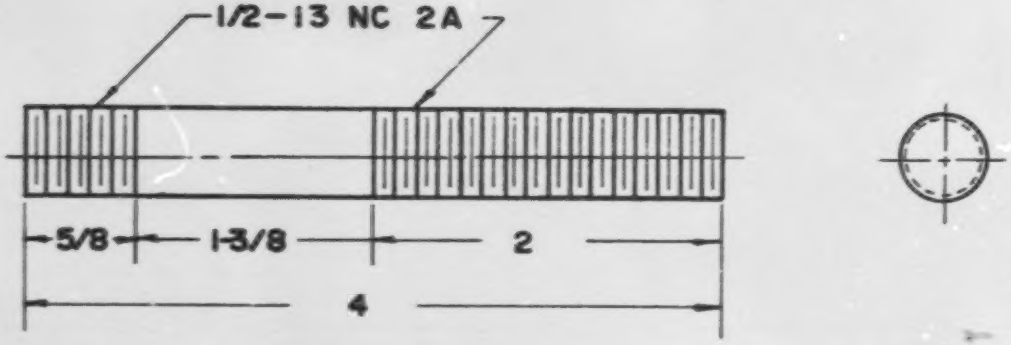
PROJCET #54

COURSES: Measuring, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 1/2" diameter x 4½" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 21	Grinding a threading tool
M - 20	Using a center gage
L - 22	Cutting an external V-thread in a lathe
M - 19	Using a thread pitch gage
M - 38	Measuring with a thread micrometer


1/2-13 NC 2A
5/8
1-3/8
2
4

MATERIAL: 1 EA. CRS ROUND 1/2 DIA. X 4-1/4

TOLERANCE: + − 1/16

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TITLE SET UP BOLT	NO 461		

460

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SET-UP BOLTS
(½" x 4" LONG)

PROJECT #54

SPECIAL INSTRUCTIONS: Check the pitch diameter of the thread to be cut in the machinery's handbook or machinist practical guide.

PROCEDURES:

1. Check the stock size
2. Cut to 4¼" long
3. Chuck in a three-jaw chuck
    a. Have ½" longer than thread length extending from the chuck
4. Face
5. Center drill
    a. Use a #3 center drill
6. Insert center
7. Grind a 60° V-threading tool
8. Turn compound rest 29° off 90° from the center line to the right
9. Insert tool in tool holder
10. Center the tool
    a. Use a center gage
    b. Secure the tool
    c. Insure the top of the tool is flat
        (1) The 16½° negative rake may have to be changed due to set up.
11. Set the machine to cut the number of threads desired
12. Set the speed
13. Layout the length of the threads to be cut
14. Move the compound in until the micrometer collar reads zero
    a. Insure there is enough travel to cut to thread depth

15. Move the cross slide in until the tool touches the work
16. Zero the cross slide micrometer collar
17. Move the tool to the starting end of the work
18. Move the compound rest .005" in
19. Engage the half nut lever taking a cut
    a. Use a numbered line
        (1) This will depend on lathe manufacturer
20. Back tool out using the cross slide
    a. When the length of thread to be cut has been reached
21. Disengage the half nut
22. Check the number of threads cut
    a. Use a thread pitch gage
23. Move the cross slide in to the previously set zero
24. Advance the compound rest
25. Take more cuts
26. Check thread depth with a thread micrometer
27. Take the last .005" - .010" using the cross slide
    a. .002" per cut
    b. This will true the 60° "V"
28. Chamfer the end to thread depth
    a. Use threading tool edge
29. Reverse ends
30. Face to length and center drill
    a. Have 1/2" longer than thread length extending from chuck
31. Repeat sequence #13 - 28
32. Use a nut of the proper size on each end to insure a proper fit

MACHINE SHOP

PROJECT #55

SET-UP BOLT
(½" x 13 NC x 6" long)

SET-UP BOLT
(½" x 13 NC x 6" long)

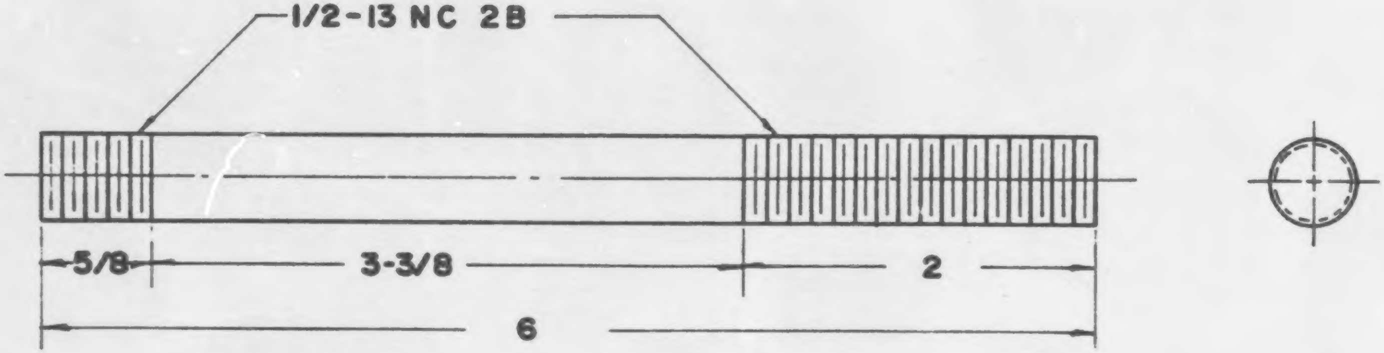
PROJECT #55

COURSES: Measuring, Lathe

MATERIALS: One Each - Cold Rolled Steel Round ½" diameter x 6¼" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
M - 20	Using a center gage
L - 22	Cutting an external V-thread in a lathe
M - 19	Using a thread pitch gage
M - 38	Measuring with a thread micrometer


1/2-13 NC 2B
5/8
3-3/8
2
6

MATERIAL: 1 EA. CRS ROUND 1/2 DIA. X 6-1/4

TOLERANCE: + − 1/16

466

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			

TITLE SET UP BOLT

NO. 467 55

BRUNING 40-105

SET-UP BOLT
(½" - 13 NC x 6" long)

PROJECT #55

SPECIAL INSTRUCTIONS: Check the pitch diameter of the thread to be cut in the machinery's handbook or machinist practical guide.

PROCEDURES:

1. Check the stock size
2. Cut to 6¼" long
3. Chuck in a three-jaw chuck
    a. Have ½" longer than the thread length extending from the chuck
4. Face
5. Center drill
    a. Use a #3 center drill
6. Insert a center
7. Follow the procedures numbers 8 through 32 of Project #54

MACHINE SHOP

PROJECT #56

SET-UP BOLT
(½" - 13 NC x 8" long)

469

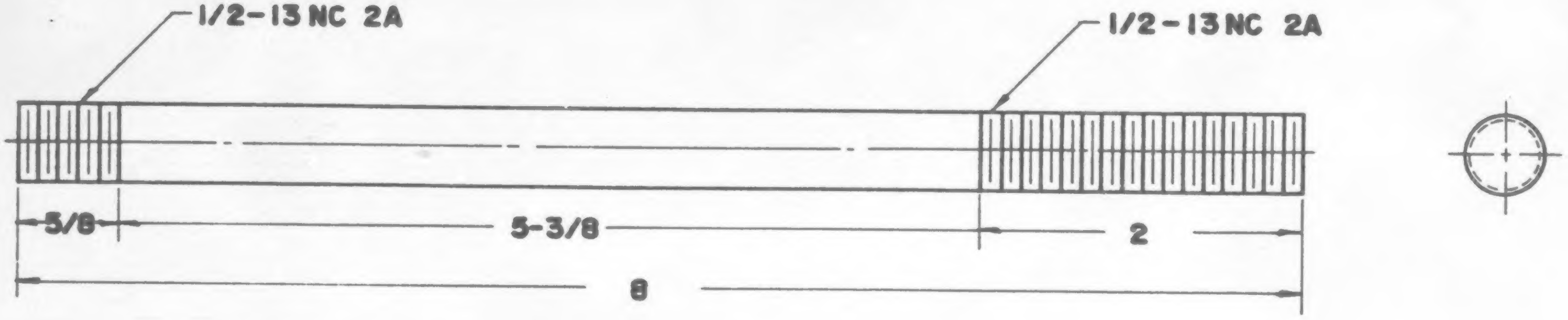
SET-UP BOLT
(½" - 13 NC x 8" long)

PROJECT #56

COURSES: Measuring, Lathe

MATERIALS: One Each - Cold Rolled Round ½" diameter x 8¼" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 10	Center drilling in a lathe
	M - 20	Using a center gage
	L - 22	Cutting an external V-thread in a lathe
	M - 19	Use a thread pitch gage
	M - 38	Measuring with a thread micrometer


1/2-13 NC 2A
1/2-13 NC 2A
5/8
5-3/8
2
8

MATERIAL: 1 EA. CRS ROUND 1/2 DIA. X 8-1/4

TOLERANCE: + - 1/64

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD			
AP'VD			

TITLE SET UP BOLT

NO. 472

56

471

BRUNING 40-105

SET-UP BOLT
(½" - 13 NC x 8" long)

PROJECT #56

SPECIAL INSTRUCTIONS:

1. Check the stock size
2. Cut to 8¼" long
3. Chuck in a three-jaw chuck
    a. Have ½" longer than the thread length extending from the chuck
4. Face
5. Center drill
    a. Use a #3 center drill
6. Insert a center
7. Follow the procedures #8-32 of Project #54

MACHINE SHOP

PROJECT #57

SET-UP BOLT
(3/8" - 16 NC x 4" long)

474

SET-UP BOLT
(3/8" - 16 NC x 4" long)

PROJECT #57

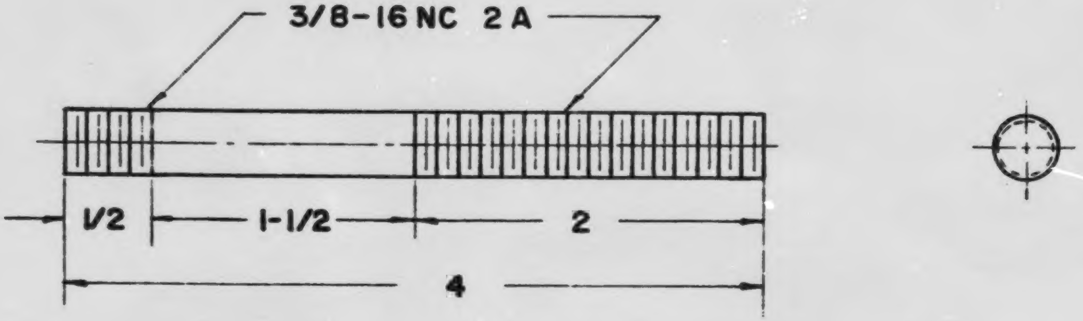
COURSES: Measuring, Lathe

MATERIALS: One Each - Cold Rolled Round 3/8" diameter x 4¼" long

TASK:

L - 7	Chucking in a four-jaw chuck
M - 41	Using a dial indicator
L - 10	Center drilling in a lathe
M - 20	Using a center gage
L - 22	Cutting an external V-thread in a lathe
M - 19	Using a thread pitch gage
M - 38	Measuring with a thread micrometer

47


3/8-16NC 2A
1/2
1-1/2
2
4

MATERIAL: 1 EA CRS ROUND 3/8 DIA. X 4-1/4

TOLERANCE: +-1/16

476

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR N GWB CKD			
AP VD			
TITLE SET UP BOLT	NO 477		

57

BRUNING 40-105

SET-UP BOLT
(3/8" - 16 NC x 4" long)

PROJECT #57

SPECIAL INSTRUCTIONS: Check the pitch diameter of the threads to be cut in the machinery's handbook or machinist practical guide.

PROCEDURES:

1. Check the stock size
2. Cut the stock 4¼" long
3. Chuck in a four-jaw chuck
    a. Have ½" longer than the thread length extending from the chuck
    b. True the stock
        (1) Use a dial indicator
4. Face
5. Center drill
    a. Use a #2 center drill
6. Insert a center
7. Follow the procedures #8-32 of Project #54

MACHINE SHOP

PROJECT #58

SET-UP BOLT
(3/8 - 16 NC x 6" long)

SET-UP BOLT
(3/8 - 16 NC x 6" long)

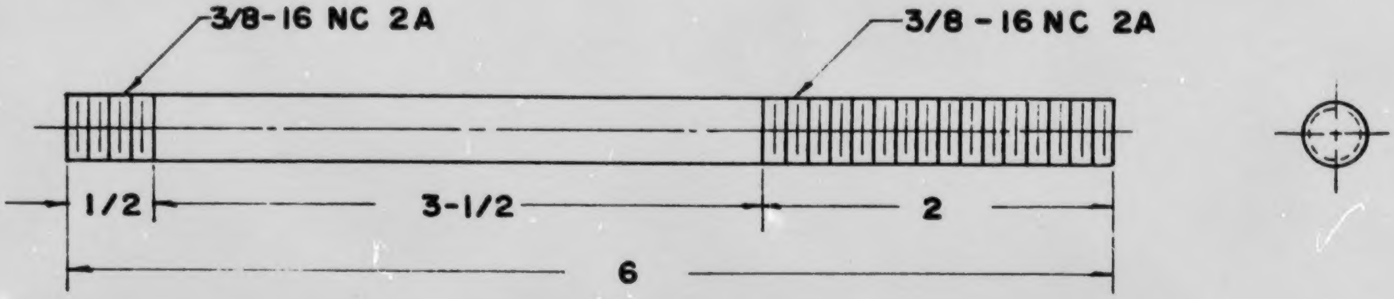
PROJECT #58

COURSES: Measuring, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 3/8" diameter x 6¼" long

TASK:	L - 7	Chucking in a four-jaw chuck
	M - 41	Using a dial indicator
	L - 10	Center drilling in a lathe
	M - 20	Using a center gage
	L - 22	Cutting an external V-thread
	M - 19	Using a thread pitch gage
	M - 38	Measuring with a thread micrometer

51


3/8-16 NC 2A
3/8 - 16 NC 2A
1/2
3-1/2
2
6

MATERIAL: 1 EA. CRS ROUND 3/8 DIA. X 6-1/4

TOLERANCE: + - 1/64

481

SCALE FULL		REVISIONS	BY	DATE
DATE				
DR N GWB	CKD			
AP VD				
TITLE SET UP BOLT			NO 482	

58

BRUNING 40-105

SET-UP BOLT
(3/8" - 16 NC x 6" long)

PROJECT #58

SPECIAL INSTRUCTIONS: Check the pitch diameter of the threads to be cut in the machinery's handbook or the machinist practical guide.

PROCEDURES:

1. Check the stock size
2. Cut the stock 6¼" long
3. Chuck in a four-jaw chuck
    a. Have ½" longer than the thread length extending from the chuck
    b. True the stock
        (1) Use a dial indicator
4. Face
5. Center drill
    a. Use a #2 center drill
6. Insert a center
7. Follow the procedures #8-32 of Project #54

MACHINE SHOP

PROJECT #59

DRILL REDUCER

484

DRILL REDUCER

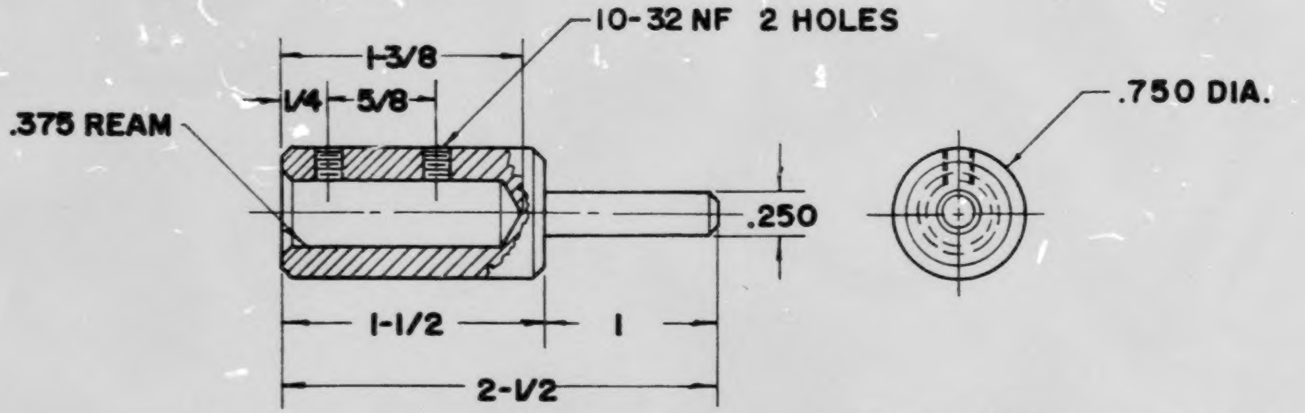
PROJECT #59

COURSES: Measuring, Bench Work, Drill Presses, Lathe

MATERIALS: One each - Cold Rolled Steel Round 3/4" diameter x 2 3/4" long
Two each - Allen Head Set Screws 10 - 32 NF x 3/16" long

TASK:

L - 7	Chucking in a four-jaw chuck
M - 41	Using a dial indicator
L - 8	Facing in a lathe
L - 14	Turning a shoulder on a lathe
M - 30	Measuring with an outside micrometer caliper
L - 17	Filing in a lathe
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
D - 1	Drilling on a drill press
B - 7	Use a tap
B - 9	Use a hand reamer
M - 36	Measuring with a small hole gage
M - 34	Measuring with a vernier caliper


10-32 NF 2 HOLES
1-3/8
1/4
5/8
.375 REAM
.750 DIA.
.250
1-1/2
1
2-1/2

NOTE: CHAMFER ALL EDGES 1/16 X 45°

MATERIALS: 1 EA. CRS ROUND 3/4 DIA. X 2-3/4
2 EA. ALLEN HD. SCREWS 10-32 NF X 3/16

TOLERANCES: + - 1/32 · + - .002 · = + - .001

SCALE FULL	REVISIONS	BY	DATE
DATE			
DRN GWB / CKD			
AP'VD			

TITLE
3/8 DRILL REDUCER

NO. 487 59

486

BRUNING 40-105

DRILL REDUCER
(3/8" Drill)

PROJECT #59

SPECIAL INSTRUCTIONS: This reducer may be made to fit any drill from ¼" to 3/8" by using the reamer of your choice.

PROCEDURES:

1. Check the stock size
2. Cut to 2 3/4" length
3. Chuck in a lathe
    - a. Use a four-jaw chuck
    - b. Have 1½" extending from the chuck
    - c. True the stock in the chuck
        - (1) Use a dial indicator
4. Face one end
5. Insert a center
6. Turn the ¼" diameter to the shoulder
    - a. Insure the ¼" is parallel
        - (1) Use an outside micrometer
        - (2) File parallel if necessary
7. Reverse ends
    - a. True the stock
    - b. Use a dial indicator
    - c. Chuck on the entire ¼" surface
        - (1) Insure the shoulder is touching the chuck jaws
8. Face to length
9. Center drill
10. Drill and ream
11. Chamfer all edges

488

12. Drill and tap the holes
    a. Use a drill press
    b. Use a tap and tap wrench
13. De-bur the reamed hole after tapping
    a. Use a hand reamer
14. Check the hole size
    a. Use a small hole gage
    b. Check the length with slide vernier caliper

MACHINE SHOP

PROJECT #60

TAP DRILL EXTENSION
(1/4" - 20 NC Tap Drill)

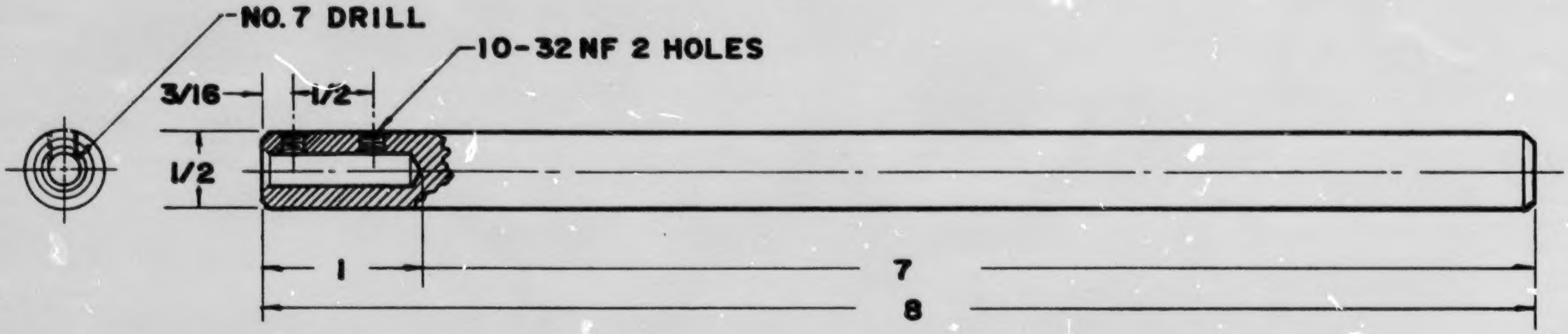
TAP DRILL EXTENSION
(¼" - 20 NC Tap Drill)

PROJECT #60

COURSES: Measuring, Drill Presses, Lathe

MATERIALS: One Each - Cold Rolled Steel Round ½" diameter x 8¼" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 7	Chucking in a four-jaw chuck
	M - 41	Using a dial indicator
	L - 10	Center drilling in a lathe
	L - 11	Drilling in a lathe
	M - 36	Measuring with a small hole gage
	D - 1	Drilling on a drill press
	D - 7	Tapping on a drill press


NO. 7 DRILL
10-32 NF 2 HOLES
3/16
1/2
1/2
1
7
8

NOTE: CHAMFER ALL EDGES 1/16 X 45°

MATERIALS: 1 EA. CRS ROUND 1/2 DIA. X 8-1/4

TOLERANCES: +-1/32 · +-.002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD.			
AP'VD.			

TITLE TAP DRILL EXTENSION (1/4-20 NC)	NO. 493

492

BRUNING 40-105

TAP DRILL EXTENSION
(¼" - 20 NC Tap Drill)

PROJECT #60

PROCEDURES:

1. Check the stock size
2. Cut to 8¼" length
3. Chuck in a lathe
   - a. Use a three-jaw chuck
   - b. Have ½" extending from the chuck
4. Face one end
5. Layout length
6. Chuck in a four-jaw chuck
   - a. Have 1" extending from the chuck
   - b. Indicate true
     - (1) Use a dial indicator
7. Face to length
8. Center drill
9. Drill
   - a. Check with a small hole gage
10. Chamfer all edges
11. Layout the tapped hole locations
12. Drill and tap the holes
    - a. Use a drill press
13. De-bur the hole

494

MACHINE SHOP

PROJECT #61

TAP DRILL EXTENSION
(5/16" - 18 NC Tap Drill)

495

TAP DRILL EXTENSION
(5/16" - 18 NC Tap Drill)

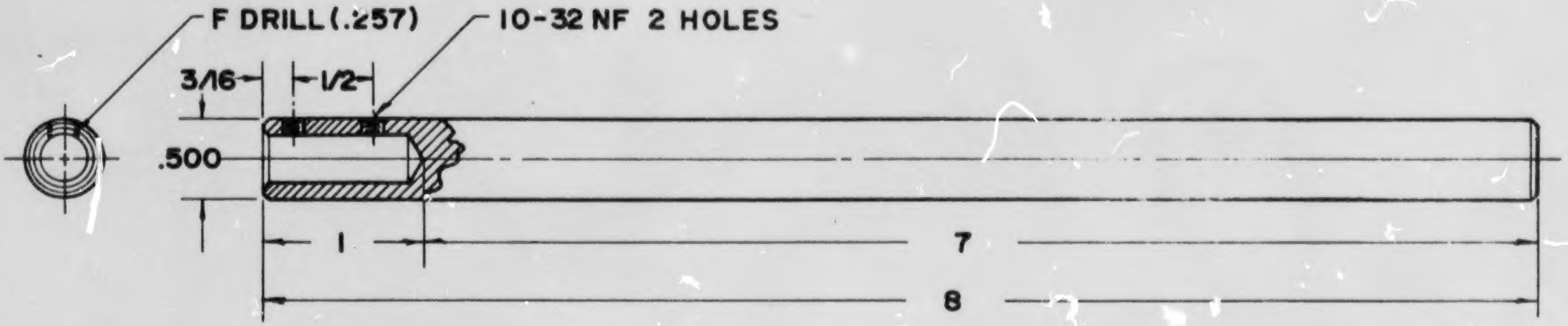
PROJECT #61

COURSES: Measuring, Drill Presses, Lathe

MATERIALS: One Each - Hot Rolled Steel Round 3/4" diameter x 8¼" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 13	Working between centers
L - 34	Using a follow rest on a lathe
M - 30	Measuring with an outside micrometer caliper
M - 41	Using a dial indicator
L - 11	Drilling in a lathe
M - 36	Measuring with a small hole gage
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press


F DRILL (.257)
10-32 NF 2 HOLES
3/16
1/2
.500
1
7
8

NOTE: CHAMFER ALL EDGES 1/16 X 45°

MATERIAL: HRS ROUND 3/4 DIA. X 8- 1/4

TOLERANCES: +-1/64 · +-.002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD			
AP'VD.			

TITLE

TAP DRILL EXTENSION (5/16-18 NC)

NO.

498 61

497

65

BRUNING 40-105

TAP DRILL EXTENSION
(5/16" - 18 NC Tap Drill)

PROJECT #61

PROCEDURES:

1. Check the stock size
2. Cut the stock to 8½" long
3. Chuck in a three-jaw chuck
    a. Have 1" extending from the chuck
4. Face one end
5. Center drill
6. Reverse ends
    a. Have 1" extending from the chuck
7. Face to length
8. Center drill
9. Set up the lathe for turning between centers
10. Mount the stock between centers
11. Turn to .500" diameter
    a. Use a follow rest
    b. Check with an outside micrometer
12. Reverse ends
    a. Finish the cut
13. Chuck in a four-jaw chuck
    a. True the stock
        (1) Use a dial indicator
14. Drill the hole
    a. Check with a small hole gage
15. Chamfer all edges
16. Drill and tap the 10" - 32" holes

    a. Use a drill press

17. Debur the hole

    a. Use the tap drill

REFERENCES

1. Krar, S. F. and Oswald, J. W.: Grinding Technology. Albany: Delmar Publishers, 1974.

2. Lascoe, Nelson, Porter: Machine Shop - Operations and Setups. Chicago: American Technical Society, 1973

3. Oberg, Erik and Jones, F. D.: Machinery's Handbook. New York, N.Y.: Industrial Press Inc., 1976

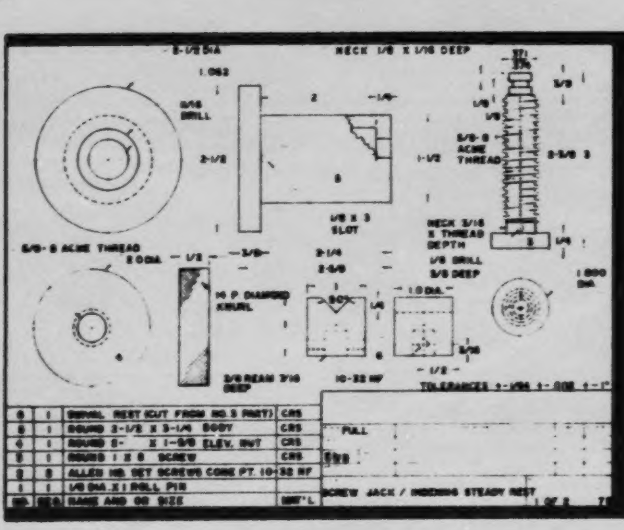
4. Morse: Machinist's Practical Guide. New Bedford, Mass: Morse Cutting Tools Division, 1978

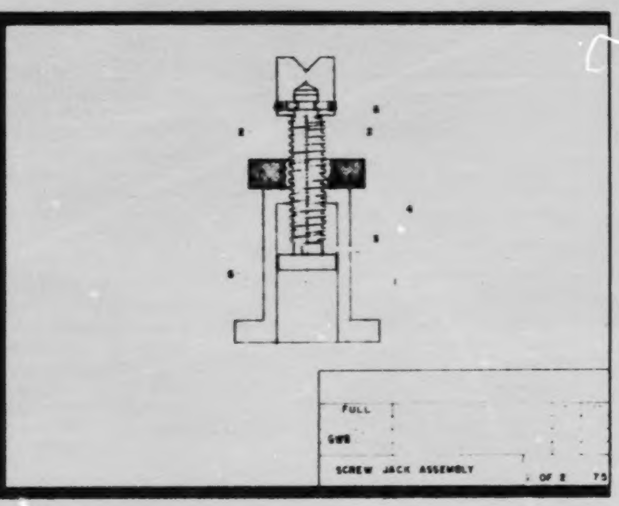
5. Krar, S.F.; Oswald, J. W. and St. Amond, J. E.: Technology of Machine Tools. New York: McGraw-Hill Book Company, Gregg Division, 1977

MACHINE SHOP PROJECTS

LATHE, MILLING MACHINES

Projects 62-78


2-1/2 DIA
NECK 1/8 X 1/16 DEEP
1.062
2
2-1/2
1-1/2
5/8-8 ACME THREAD
1/8 X 3 SLOT
NECK 3/16 X THREAD DEPTH
1/8 DRILL
3/8 DEEP
5/8-8 ACME THREAD
2-1/4
2-5/8
1.0 DIA.
16 P. DIAMOND KNURL
10-32 NF
1/2
TOLERANCES
FULL
SCREW JACK / INDEXING STEADY REST
1 OF 2


FULL
SCREW JACK ASSEMBLY
OF 2
75

STUDENT MANUAL

Georgia Department of Education

This project was developed under a grant from:

Division of Program Development
Office of Vocational Education
Georgia Department of Education

Project Numbers: 98251 and 28252

to:

Augusta Area Vocational-Technical School

Author:
Raymond E. Westbrook
Instructor, Machine Shop

Drawings:
George W. Baggs, Jr.
Instructor, Drafting and Design

TABLE OF CONTENTS

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Part C: PROJECTS - 1-101:

Cover Sheet
Information Sheet
Project Drawings
Fabrication Procedures

Part D: REFERENCES

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PURPOSE

A student in Machine Shop must learn by doing. Although lectures, reading assignments, and audio-visual aids are very necessary, these methods alone will never produce a good machinist. The combination of both classroom and shop practice is essential to your training. The purpose of this Shop Project Guide is to give the necessary shop experience to complement your classroom training. This guide is based on the author's years of practical experience as a skilled machinist and as a teacher in the field. Each skill needed to complete a phase of your training has been identified. Next, projects have been devised to give hands-on experience for each skill with enough repetition so that you will become capable of using each tool or attachment for the particular machine or operation being taught. Your instructor will help you select or will assign the projects in the necessary order. You will also find the end products of these projects will be useful tools that will help in your training that follows. This serves not only to make the projects more interesting, but more enjoyable to construct. This practical training along with classroom instruction and applied learning can bring you a rewarding future as a skilled tradesman.

PROJECT LISTING (CATEGORIZED)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench

*11. Pipe flange assembly

*12. C-clamp

*13. Block and tackle

*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects

*16. Jack Stand

*17. Gear puller

18. Tool post base

506

MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (genreal purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. 1/4" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
40. Dead center
41. Plumb bob

42. Dumbbell set

43. Taper plug gage

44. Rocker dish

45. Rocker

46. Tool post body

47. Circle cutter

48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II

*50. Fly cutter

51. Tooth pick holder

*52. Pipe center

53. Taper ring gage

54. Set up bolt 1/2" x 4"

55. Set up bolt 1/2" x 6"

56. Set up bolt 1/2" x 8"

57. Set up bolt 3/8" x 4"

58. Set up bolt 3/8" x 6"

59. Drill reducer

60. Tap drill extension (1/4" - 20 NC tap drill)

61. Tap drill extension (5/16" - 18 NC tap drill)

62. Boring bar holder body jig

63. Boring bar holder body

*64. Boring bar holder base

65. Boring bar holder inner body

66. Boring bar holder base jig

67. Precision measuring tool block

*68. Milling arbor #40 - 3/8"

*69. Milling arbor #40 - 1/5"

*70. Milling arbor #40 - 5/8"

*71. Milling arbor #40 - 3/4"

*72. Lathe arbor

73. Mallet

74. Acme thread/boring tool

*75. Screw jack/indexing steady rest

76. Lathe chuck wrench

77. Internal pipe wrench

78. Buffer/grinder shaft

SHAPER

79. Splitting wedge

80. Flat strap clamp

*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks I

*83. V-blocks

84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge

86. Solid key seat

87. Water valve wrench

88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. 1/4" pitch, 1' lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

510

MACHINE SHOP

PROJECT #62

BORING BAR HOLDER BODY JIG

BORING BAR HOLDER BODY JIG

PROJECT #62

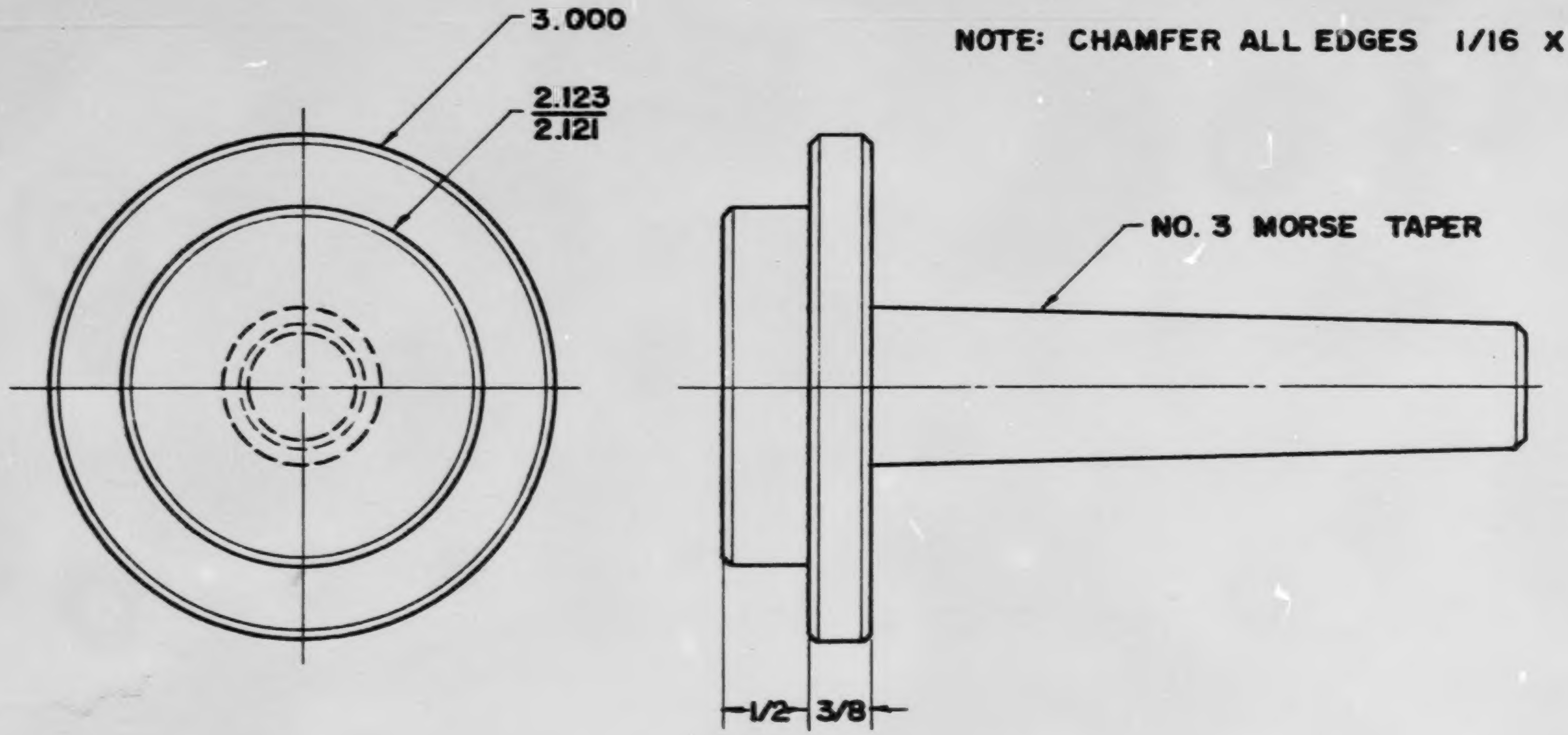
COURSES: Lathe

MATERIALS: One Each - Cold Rolled Steel Round 3" diameter x 4½" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 13	Working between centers
L - 9	Turning in a lathe
L - 30	Cutting a taper by off-setting a tailstock
L - 14	Turning a shoulder on a lathe

512


3.000
2.123
2.121
NO. 3 MORSE TAPER
1/2
3/8

NOTE: CHAMFER ALL EDGES 1/16 X 45°

MATERIAL: CRS ROUND 3 DIA. X 4-1/2

UNLESS OTHERWISE SPECIFIED TOLERANCES SHALL BE: + - 1/32 · + - .002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD			
AP'VD			

TITLE
BORING BAR HOLDER BODY JIG

NO.
514

513

BRUNING 40-105

BORING BAR HOLDER BODY JIG

PROJECT #62

SPECIAL INSTRUCTIONS: This project is to be mounted in a rotary table to center the boring bar body for drilling.

PROCEDURES:

1. Check stock size
2. Cut the stock to 4½" long
3. Chuck in a three-jaw chuck in a lathe
4. Face
5. Center drill
6. Reverse ends
7. Face to length
8. Center drill
9. Mount between centers
10. Straight turn the taper to .938
    a. Check with a micrometer to insure center alignment
11. Off-set the tailstock end
12. Cut the taper
    a. Check the taper with chalk and a morse taper gage
13. Reverse ends
    a. Straighten the centers
14. Turn the 2.123" diameter shoulder
15. Chamfer all edges

MACHINE SHOP

PROJECT #63

BORING BAR HOLDER BODY

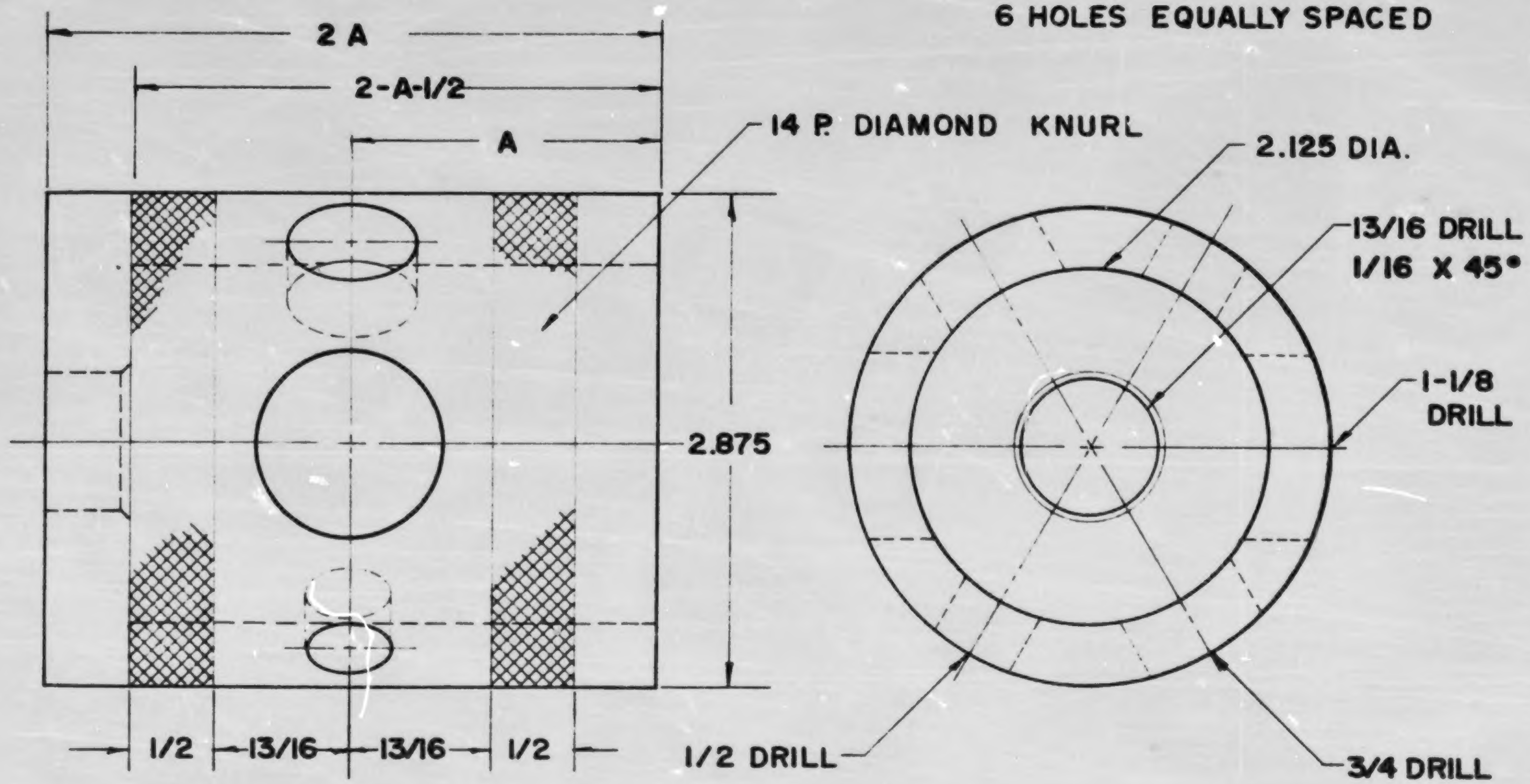
BORING BAR HOLDER BODY

PROJECT #63

COURSES: Drill Presses, Lathe

MATERIALS: One Each - Hot Rolled Steel Round 3" diameter x 5" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 10	Center drilling in a lathe
	L - 4	Grinding a facing tool
	L - 1	Grinding a general purpose lathe tool
	L - 8	Facing in a lathe
	L - 9	Turning in a lathe
	L - 15	Knurling on a lathe
	L - 11	Drilling in a lathe
	L - 31	Boring in a lathe
	M - 32	Measuring with an inside micrometer
	D - 1	Drilling on a drill press
	D - 9	Use a rotary table on a drill press
	L - 16	Cutting off in a lathe


6 HOLES EQUALLY SPACED
2 A
2-A-1/2
A
14 P. DIAMOND KNURL
2.125 DIA.
13/16 DRILL
1/16 X 45°
1-1/8
DRILL
2.875
1/2
13/16
13/16
1/2
1/2 DRILL
3/4 DRILL

NOTE: A = DISTANCE FROM THE TOP OF
THE COMPOUND REST TO THE CENTER-
LINE OF THE LATHE.

MATERIAL: HRS ROUND 3 DIA. X 5

TOLERANCES: +− 1/64 · +− .002

518

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR N GWB | CKD			
AP VC			

TITLE OUTER BODY

NO 519

63

BORING BAR HOLDER BODY

PROJECT #63

SPECIAL INSTRUCTIONS: The boring bar holder body may be used with Project numbers 64 and 65 or each project may be made as replacement parts.

PROCEDURES:

1. Check stock size
    a. Check dimension A
2. Cut to 5" long
3. Chuck in a lathe
    a. Use a three-jaw chuck
    b. Have ½" longer than is needed extending from the chuck
4. Center drill
5. Insert a center
6. Grind a facing tool
7. Grind a general purpose lathe tool
8. Face the stock
    a. Use a facing tool
9. Turn the outside diameter (OD)
    a. Use a general purpose lathe tool
10. Knurl
11. Remove center
12. Drill
    a. Use a 13/16 drill
    b. Drill at least ½" longer than the length of the body
13. Drill using as large a drill as the lathe will handle
    a. ½" less than length of body length
14. Bore

15. Cut to length

    a. Use a horizontal or power hacksaw

    b. Allow 1/4' for facing

16. Face to length

17. Mount the boring bar body jig in a rotary table

18. Mount the table on a drill press

    a. Mount the face of the table vertical

19. Mount the body on the jig

    a. Use strap clamps

    b. Use set up bolts

    c. Use T-slot nuts

20. Drill the holes

21. Chuck in a lathe

    a. Use a three-jaw chuck

22. Cut in half

    a. Use a cut-off tool

23. Chamfer all edges

MACHINE SHOP

PROJECT #64

BORING BAR HOLDER BASE

522

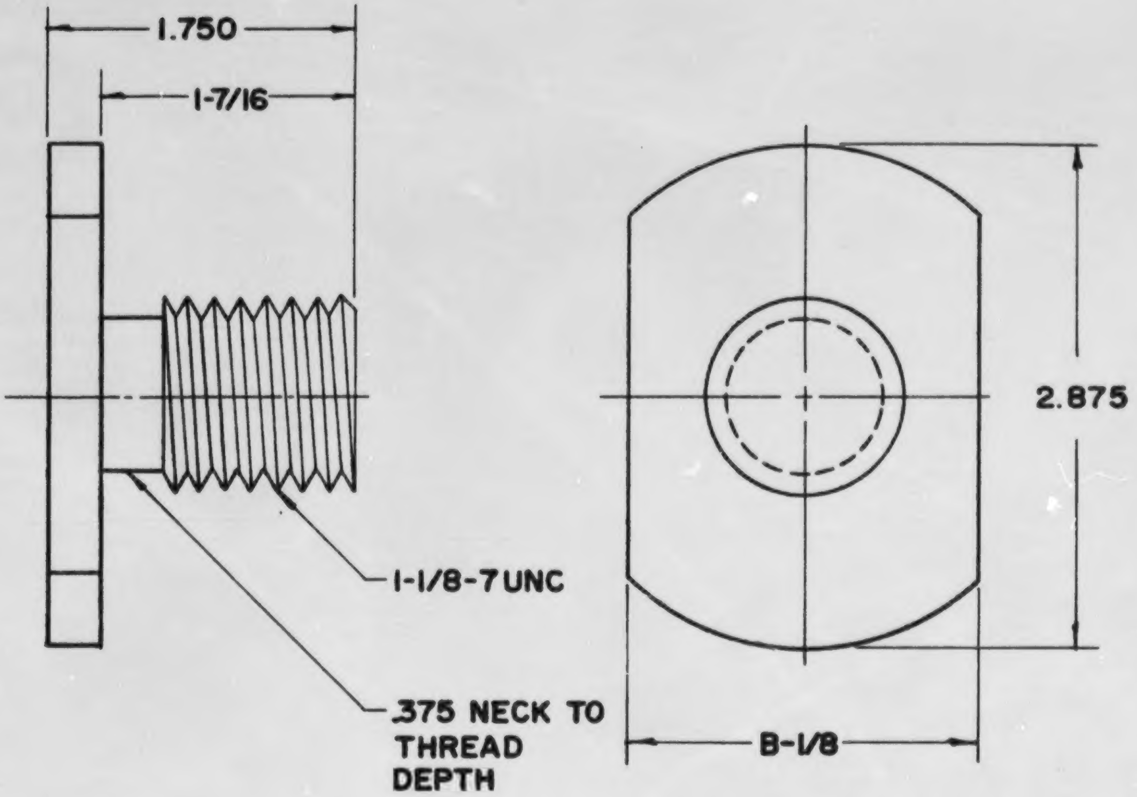
BORING BAR HOLDER BASE

PROJECT #64

COURSES: Measuring, Lathe, Shapers

MATERIALS: One Each - Cold Rolled Steel Round 2 7/8" diameter x 3" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 10	Center drilling in a lathe
	L - 14	Turning a shoulder on a lathe
	L - 35	Necking in a lathe
	L - 22	Cutting on external V-thread in a lathe
	M - 38	Measuring with an thread micrometer
	M - 30	Measuring with an outside micrometer caliper
	SP - 1	Truing a vice in a shaper
	SP - 2	Shaping a horizontal surface
	M - 34	Measuring with a vernier caliper


1.750
1-7/16
2.875
1-1/8-7UNC
.375 NECK TO THREAD DEPTH
B-1/8

MATERIAL: 1 EA. CRS ROUND 2-7/8 DIA. X 3

TOLERANCES: +- 1/64 · +-.002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD			
AP'VD			

TITLE T- SLOT BASE

NO 525

524

64

BORING BAR HOLDER BASE

PROJECT #64

SPECIAL INSTRUCTIONS: The base may be used with Project numbers 63 and 65 or each Project may be made as replacement parts.

See Project #54 for thread cutting procedures.

Part of this Project will require basic Machine Shop skills while others will require more advanced skills.

PROCEDURES:

1. Check the stock size
2. Cut to 3" long
3. Chuck in a three-jaw chuck
   a. Have 1 3/4" extending from the chuck
4. Face
5. Center drill
6. Turn to 1 1/8" diameter to 1 7/16" long
7. Neck
8. Cut the threads
   a. Check with a thread micrometer
9. Cut in a saw to 2" long
10. Screw into base jig Project #66 or 1 1/8 - 7 nut
11. Chuck on the base jig or nut
12. Turn the compound parallel to the center line of lathe
13. Face to .3125 length
   a. Use the micrometer collar on the compound
   b. Use a micrometer
14. Layout the parallel flats
15. True a shaper vice

16. Mount project in vice
17. Shape the flat
18. Turn 180°
19. Shape second flat parallel
    a. Use a slide vernier caliper to check parallel
20. Debur all edges

MACHINE SHOP

PROJECT #65

BORING BAR HOLDER INNER BODY

BORING BAR HOLDER INNER BODY

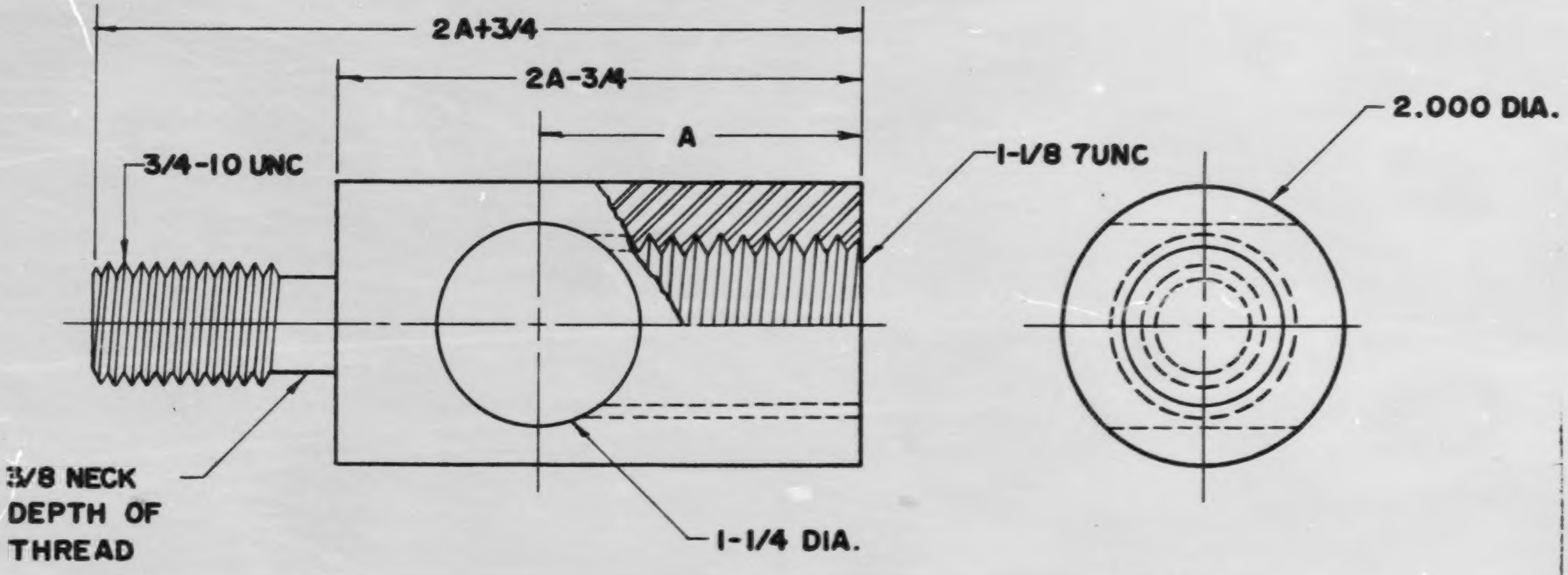
PROJECT #65

COURSES: Measuring, Drill Presses, Lathe

MATERIALS: One Each - Cold Rolled Steel Round 2" diameter x 5" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 10	Center drilling in a lathe
	L - 5	Grinding a necking tool
	L - 14	Turn a shoulder on a lathe
	L - 35	Necking in a lathe
	L - 21	Grinding a threading tool
	M - 20	Using a center gage
	L - 22	Cutting an external V-thread in a lathe
	M - 38	Measuring with thread micrometer
	M - 35	Measuring with a vernier height gage
	D - 1	Drilling on a drill press
	L - 11	Drilling in a lathe
	L - 23	Cutting internal threads in a lathe

529


2A+3/4
2A-3/4
A
3/4-10 UNC
1-1/8 7UNC
2.000 DIA.
3/8 NECK
DEPTH OF
THREAD
1-1/4 DIA.

MATERIAL: 1 EA. CRS ROUND 2 DIA. X 5

TOLERANCES: +-1/64 · +-.002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR. GWB CKD			
AP VD			

TITLE INNER BODY	NO 531

530

BRUNING 40-105

BORING BAR HOLDER INNER BODY

PROJECT # 65

SPECIAL INSTRUCTIONS: The inner body may be used with Project numbers 63 and 64 or each Project may be made as replacement parts. See Project #54 for thread cutting procedures.

PROCEDURES:

1. Check the stock size
2. Cut to 5" long
3. Chuck in a three-jaw chuck
4. Face
5. Center drill
6. Insert center
7. Grind a necking tool
8. Turn the 3/4" diameter shoulder
9. Neck
10. Grind a V-threading tool
    a. Use a center gage
11. Cut the threads
    a. Check with a thread micrometer
12. Reverse ends
13. Face to length
14. Layout the 1¼" hole
    a. Use a vernier height gage
15. Drill the 1¼" hole
    a. Use a drill press
16. Re-chuck in a three-jaw chuck
17. Center drill
18. Drill for threading

19. Set up the boring bar for internal threading

20. Thread the hole

    a. The compound rest must be turned 29° to the left

    b. Use a boring bar holder base to check the thread size

21. Chamfer all edges

533

MACHINE SHOP

PROJECT #66

BORING BAR HOLDER BASE JIG

BORING BAR HOLDER BASE JIG

PROJECT #66

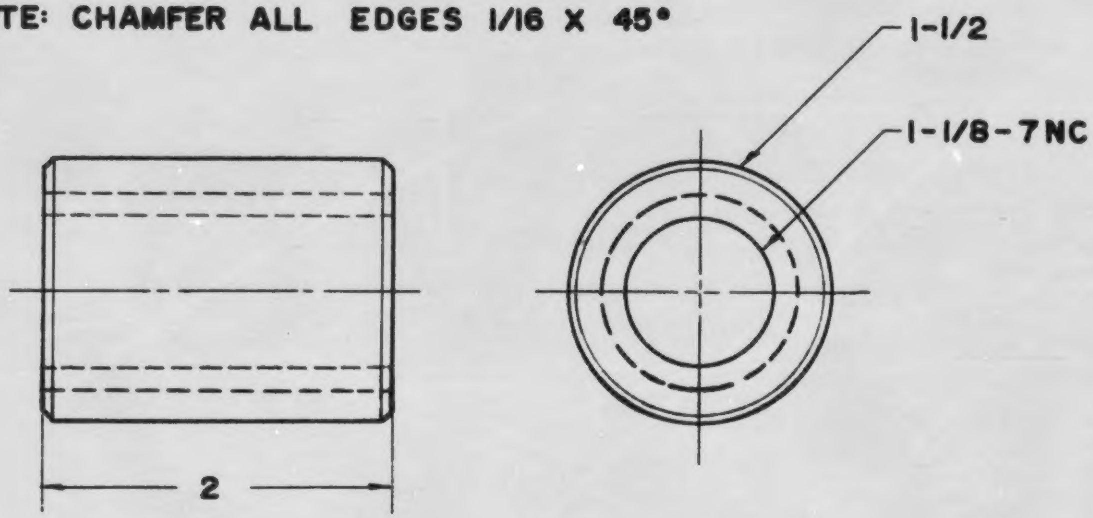
COURSES: Measuring, Lathe

MATERIALS: One Each - Cold Rolled Steel round 1½" diameter x 2¼" long

TASK:

L - 7	Chucking in a four-jaw chuck
M - 41	Using a dial indicator
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 23	Cutting internal threads in a lathe

NOTE: CHAMFER ALL EDGES 1/16 X 45°



MATERIAL: 1 EA. CRS ROUND 1-1/2 DIA. X 2-1/4

TOLERANCE: + − 1/64

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD			
AP VD			

536

TITLE
BORING BAR HOLDER BASE JIG

NO. 537

66

BORING BAR HOLDER BASE JIG

PROJECT #66

SPECIAL INSTRUCTIONS: This project may be used in support of Project #65 as a convenient way to hold the base for facing.

PROCEDURES:

1. Check the stock size
2. Cut to 2¼" long
3. Chuck in a four-jaw chuck
    a. True the stock
        (1) Use a dial indicator
4. Face one end
5. Center drill
6. Drill
7. Cut the threads
    a. Use a boring bar
8. Reverse ends
9. Face to length
10. Chamfer all edges

MACHINE SHOP

PROJECT #67

PRECISION MEASURING TEST BLOCK

PRECISION MEASURING TEST BLOCK

PROJECT #67

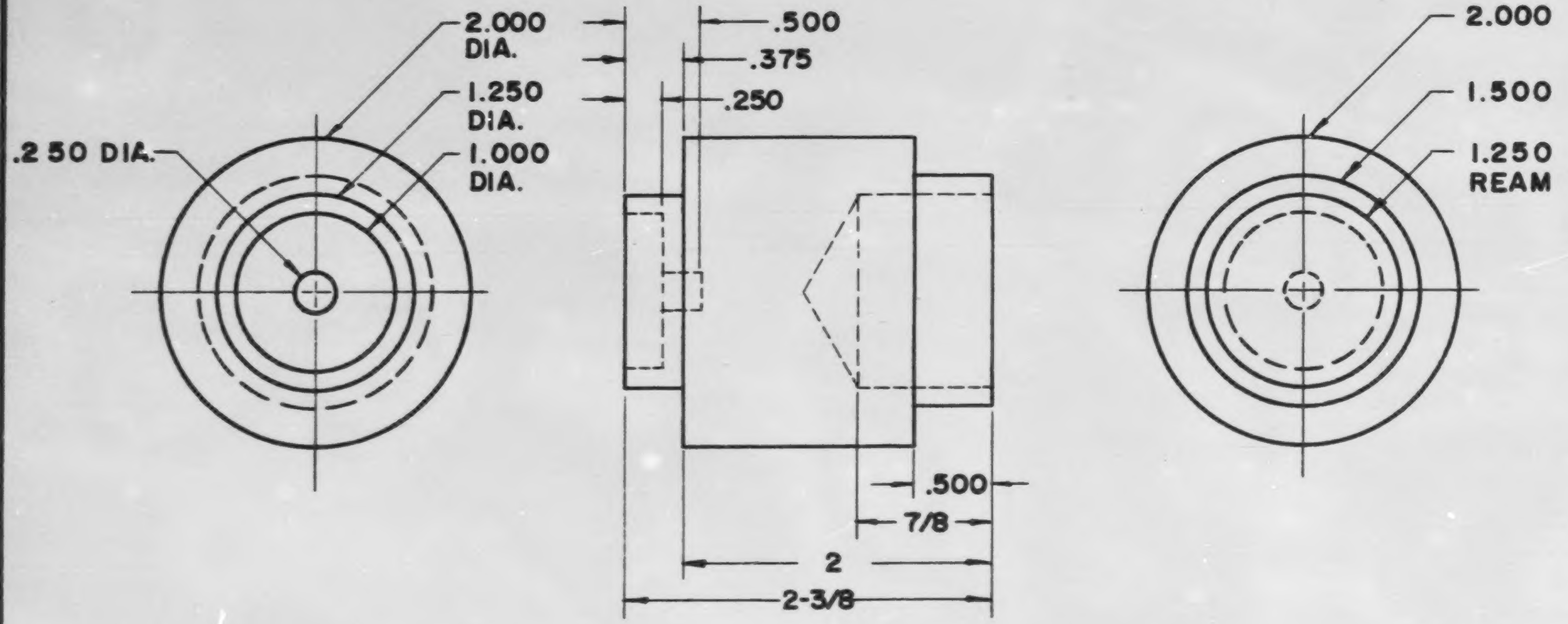
COURSES: Measuring, Lathe

MATERIALS: One Each - Aluminum Round 6061-T6 2½" Long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling on a lathe
L - 9	Turning in a lathe
M - 33	Measuring with a micrometer depth gage
M - 30	Measuring with an outside micrometer caliper
L - 11	Drilling in a lathe
L - 31	Boring in a lathe
M - 41	Using a dial indicator

540


2.000
DIA.
1.250
DIA.
.2 50 DIA.
1.000
DIA.
.500
.375
.250
.500
7/8
2
2-3/8
2.000
1.500
1.250
REAM

MATERIAL: I EA. ALUMINUM ROUND 6061 T-6 2 DIA. X 2-1/2 TOLERANCES: +- 1/64 · +-.002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR N GWB CKD			
AP VD			

TITLE
PRECISION MEASURING TEST BLOCK

NO 542

541

67

PRECISION MEASURING TEST BLOCK

PROJECT #67

SPECIAL INSTRUCTIONS: This project when completed may be used for testing first quarter students on semi-precision or precision measuring tools.

The material may be altered but must be stored in rust preventive environment if made of steel.

PROCEDURES:

1. Check stock size
2. Cut to 2½" long
3. Chuck in a three-jaw chuck
4. Face
5. Center drill
6. Insert Center
7. Turn to 1.500" diameter
    a. Face to length
        (1) Use the micrometer collar on the cross slide
        (2) Use a micrometer depth gage
    b. Check the diameter with an outside micrometer
8. Drill
9. Bore to 1.250" diameter
10. Reverse ends
11. Face to length
12. Turn to 1.250 diameter
13. Counterbore the .250 hole
    a. Use a single end cutting end mill
        (1) Mount in a drill chuck
        (2) Cut to depth with the tailstock

543

  A. Start the cut

  B. Mike with a micrometer depth gage

  C. Control the tailstock movement with a dial indicator mounted on the ways, the plunger touching the face of the spindle

15. Bore and face the 1.000" diameter hole

 a. Use a micrometer stop or compound to control the depth

16. Chamfer all edges

544

MACHINE SHOP

PROJECT #68

MILLING ARBOR #40 TAPER - 3/8"

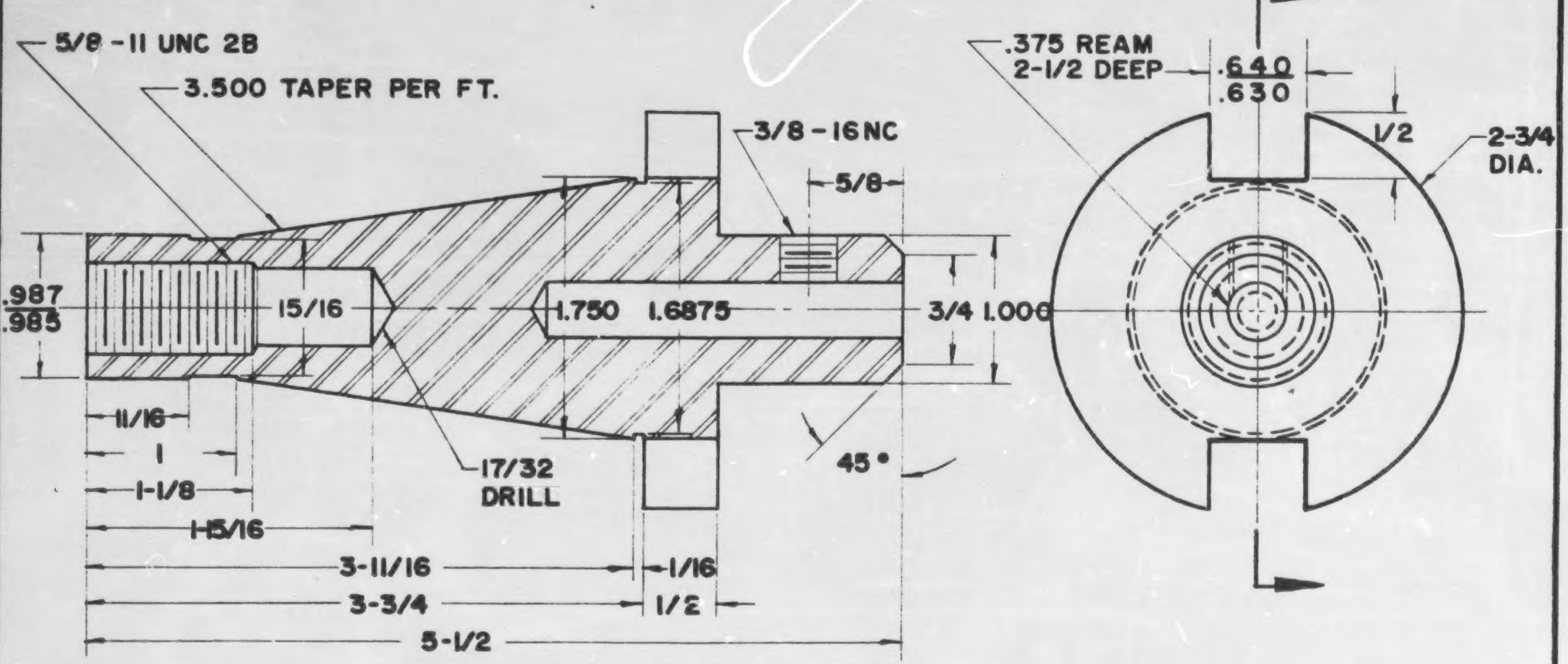
MILLING ARBOR #40 TAPER - 3/8"

PROJECT #68

COURSES: Drill Presses, Lathe, Milling Machines

MATERIALS: One each - Cold Rolled Steel Round 2 3/4" diameter x 5 3/4" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 10	Center drilling in a lathe
	L - 14	Turn a shoulder on a lathe
	L - 28	Cutting a taper with the compound rest
	L - 11	Drilling in a lathe
	L - 12	Reaming in a lathe
	L - 24	Tapping in a lathe
	L - 13	Working between centers
	L - 5	Grind a necking tool
	L - 35	Necking in a lathe
	L - 9	Turning in a lathe
	L - 29	Cutting a taper with the taper attachment
	D - 1	Drilling on a drill press
	D - 7	Tapping on a drill press
	ML - 14	Indexing on a mill
	ML - 3	Slot milling on a horizontal mill


5/8 -11 UNC 2B
3.500 TAPER PER FT.
3/8 - 16NC
5/8
.375 REAM
2-1/2 DEEP
.640
.630
1/2
2-3/4
DIA.
.987
.985
15/16
1.750
1.6875
3/4
1.000
11/16
1
1-1/8
1-15/16
17/32
DRILL
45°
3-11/16
1/16
3-3/4
1/2
5-1/2

MATERIAL: CRS ROUND 2-3/4 DIA. X 5-3/4

UNLESS OTHERWISE SPECIFIED
TOLERANCES: + - 1/64 · + - .002 · + - 1°

547

SCALE FULL	REVISIONS	BY	DATE
DATE			
DRN GWB / CKD			
AP VD			

TITLE
MILLING ARBOR # 40-3/8

NO 548

68

MILLING ARBOR #40 TAPER - 3/8"

PROJECT #68

SPECIAL INSTRUCTIONS: This project may be altered to satisfy the needs of other sizes of milling tapers by referring to the machinery's handbook for tapers national milling.

Parts of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCEDURES:

1. Check the stock size
2. Cut to 5 3/4" length
3. Chuck in a three-jaw chuck
4. Face and center drill
5. Turn to 1.000 diameter
6. Cut the taper
    a. Use the compound rest
7. Remove the center
8. Drill and ream the 3/8" reamed hole
9. Center drill for center
    a. Reverse ends
10. Chuck on the pre-turned diameter
11. Face to length
12. Center drill
13. Drill and tap
14. Re-center drill for center
15. Set-up between centers
16. Turn the 1.750 diameter
17. Grind a necking tool

18. Neck at the shoulder

19. Turn the .987 diameter 1" long

20. Neck

21. Cut the taper

    a. Use a taper attachment

22. Mount in a drill press

23. Drill and tap the set screw hole

    a. Remove burrs

24. Mount in a horizontal milling machine

    a. Mount in a dividing head

        (1) Between centers

25. Mill the driver slots

26. Chamfer all edges

MACHINE SHOP

PROJECT #69

MILLING ARBOR #40 TAPER - ½

551

MILLING ARBOR #40 TAPER - ½

PROJECT #69

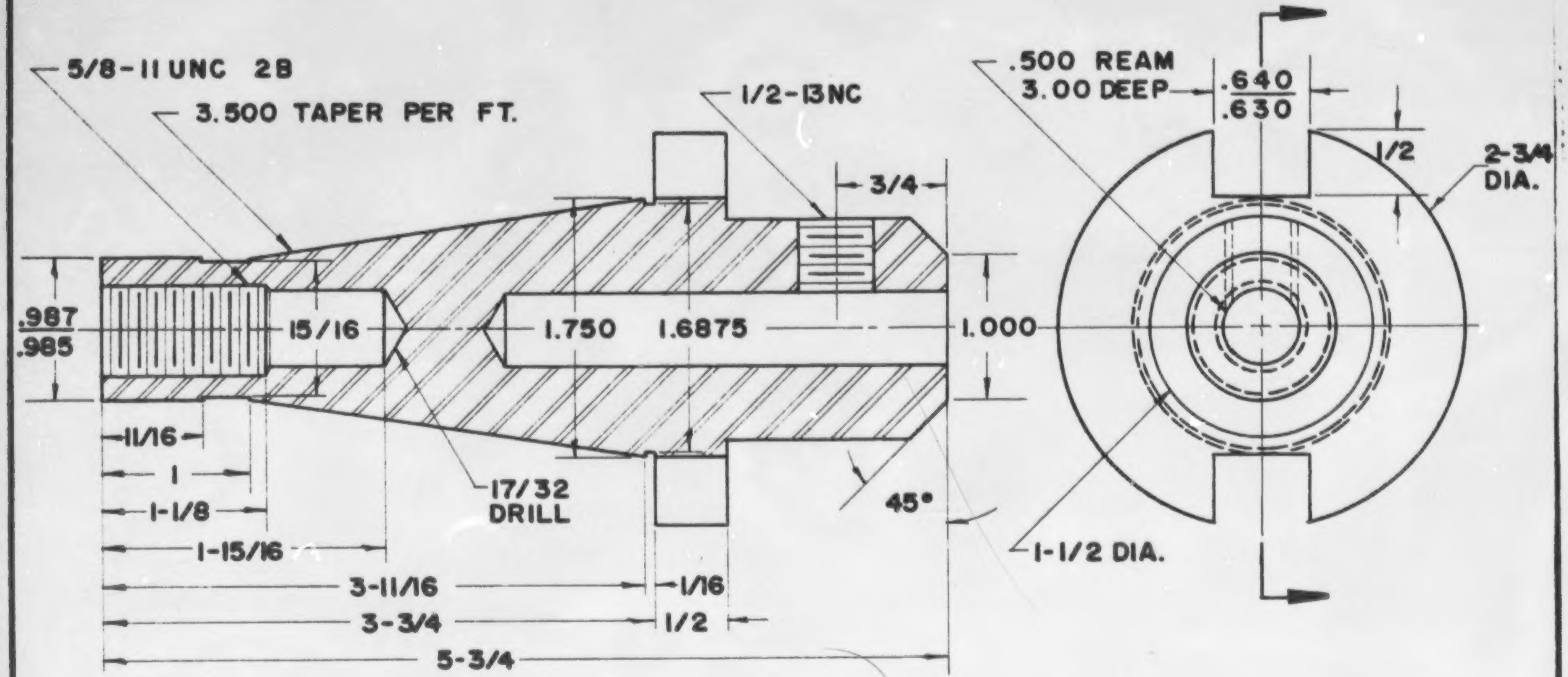
COURSES: Drill Presses, Lathe, Milling Machines

MATERIALS: One Each - Cold Rolled Steel Round 2 3/4" diameter x 6" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 14	Turning a shoulder on a lathe
L - 28	Cutting a taper with the compound rest
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
L - 24	Tapping in a lathe
L - 13	Working between centers
L - 5	Grind a necking tool
L - 35	Necking in a lathe
L - 9	Turning in a lathe
L - 29	Cutting a taper with the taper attachment
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press
ML - 14	Indexing on a mill
ML - 3	Slot milling on a horizontal mill

552


5/8-11 UNC 2B
3.500 TAPER PER FT.
1/2-13NC
3/4
.500 REAM
3.00 DEEP
.640
.630
1/2
2-3/4
DIA.
.987
.985
15/16
1.750
1.6875
1.000
11/16
1
1-1/8
1-15/16
17/32
DRILL
45°
1-1/2 DIA.
3-11/16
1/16
3-3/4
1/2
5-3/4

MATERIAL: CRS ROUND 2-3/4 DIA. X 6

UNLESS OTHERWISE SPECIFIED
TOLERANCES: +- 1/64 · +- .002 · +- 1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR N GWB	CKD		
AP VD			

TITLE MILLING ARBOR #40-1/2

NO 554

553

69

MILLING ARBOR #40 TAPER - ½"

PROJECT #69

SPECIAL INSTRUCTIONS: This project may be altered to satisfy the needs of other sizes of milling tapers by referring to the Machinery's Handbook for tapers national milling.

Part of this project will require basic Machine Shop skills while other parts will require more advanced skills.

PROCEDURES:

1. Check the stock size
2. Cut to 6" long
3. Chuck in a three-jaw chuck
4. Face
5. Center drill
6. Insert a center
7. Turn to 1½" diameter
8. Cut the taper
    a. Use the compound rest
9. Remove the center
10. Drill and ream the ½" reamed hole
11. Center drill for a center
12. Reverse ends
13. Follow procedure #10 - 26 of Project #68

MACHINE SHOP

PROJECT #70

MILLING ARBOR #40 TAPER - 5/8"

MILLING ARBOR #40 TAPER - 5/8"

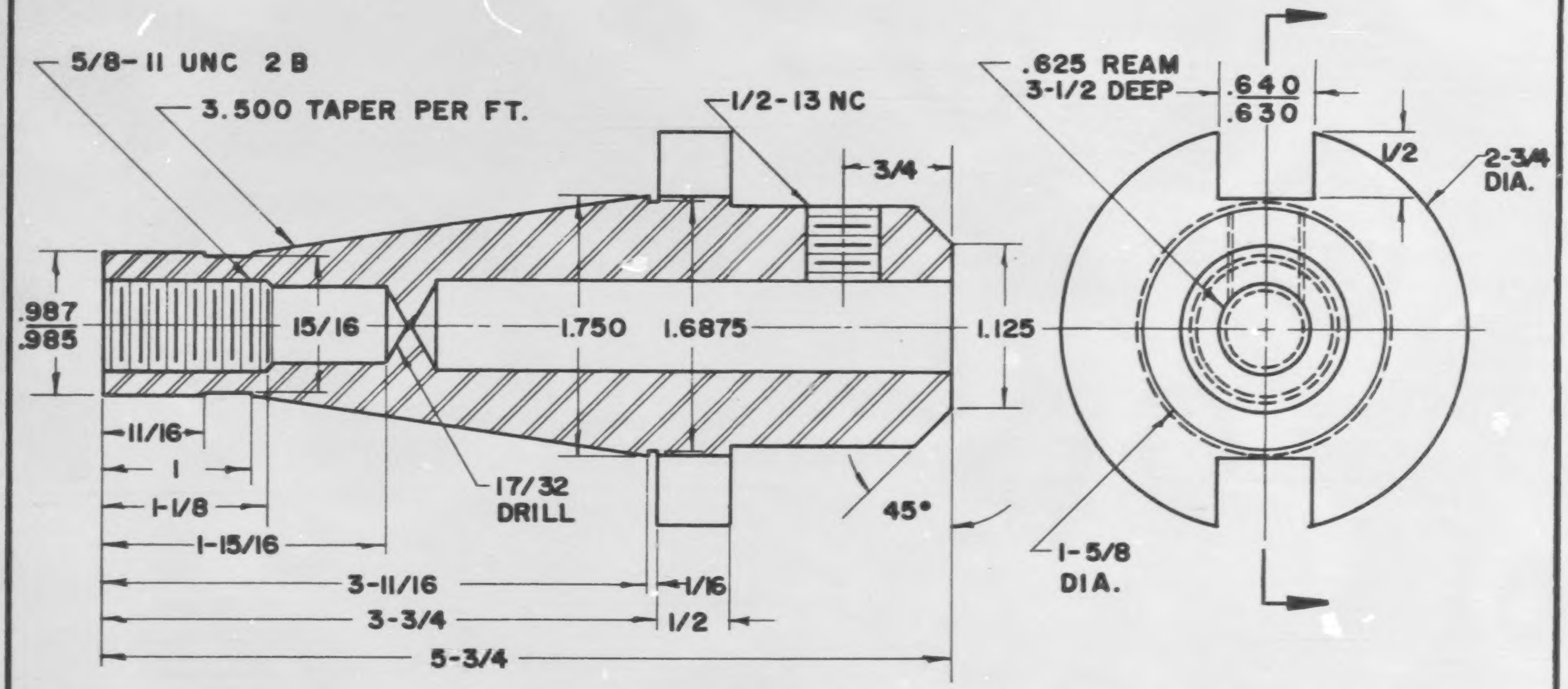
PROJECT #70

COURSES: Drill Presses, Lathe, Milling Machines

MATERIALS: One Each - Cold Rolled Steel Round 2 3/4" diameter x 6" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center Drilling in a lathe
L - 14	Turning a shoulder on a lathe
L - 28	Cutting a taper with a compound rest
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
L - 24	Tapping in a lathe
L - 13	Working between centers
L - 5	Grinding a necking tool
L - 35	Necking in a lathe
L - 9	Turning in a lathe
L - 29	Cutting a taper with the taper attachment
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press
ML - 14	Indexing on a mill
ML - 3	Slot milling on a horizontal mill


5/8-11 UNC 2B
3.500 TAPER PER FT.
1/2-13 NC
3/4
.987
.985
15/16
1.750
1.6875
1.125
11/16
1
1-1/8
1-15/16
17/32
DRILL
45°
3-11/16
1/16
3-3/4
1/2
5-3/4
.625 REAM
3-1/2 DEEP
.640
.630
1/2
2-3/4
DIA.
1-5/8
DIA.

MATERIAL: CRS ROUND 2-3/4 DIA. X 6

UNLESS OTHERWISE SPECIFIED
TOLERANCES: +-1/64· +-.002· +-1°

558

SCALE FULL		REVISIONS	BY	DATE
DATE				
DR'N. GWB	CKD.			
AP'VD.				

TITLE
MILLING ARBOR #40-5/8

NO.
559

70

BRUNING 40-105

MILLING ARBOR #40 TAPER - 5/8"

PROJECT #70

SPECIAL INSTRUCTIONS: This project may be altered to satisfy the needs of other sizes of milling tapers by referring to the Machinery's Handbook for tapers national milling.

Part of this project may require basic Machine Shop skills while other parts will require more advanced skills.

PROCEDURES:

1. Check the size of the stock
2. Cut to 6" long
3. Chuck in a three-jaw chuck
4. Face
5. Center drill
6. Insert a center
7. Turn to 1 5/8" diameter
8. Cut the taper
    a. Use the compound rest
9. Remove the center
10. Drill and ream the 5/8" hole
11. Cut an internal 60° included angle for a center
    a. Use the compound rest
12. Reverse ends
13. Follow procedures No. 10 - 26 of Project #68

569

MACHINE SHOP

PROJECT #71

MILLING ARBOR #40 - 3/4"

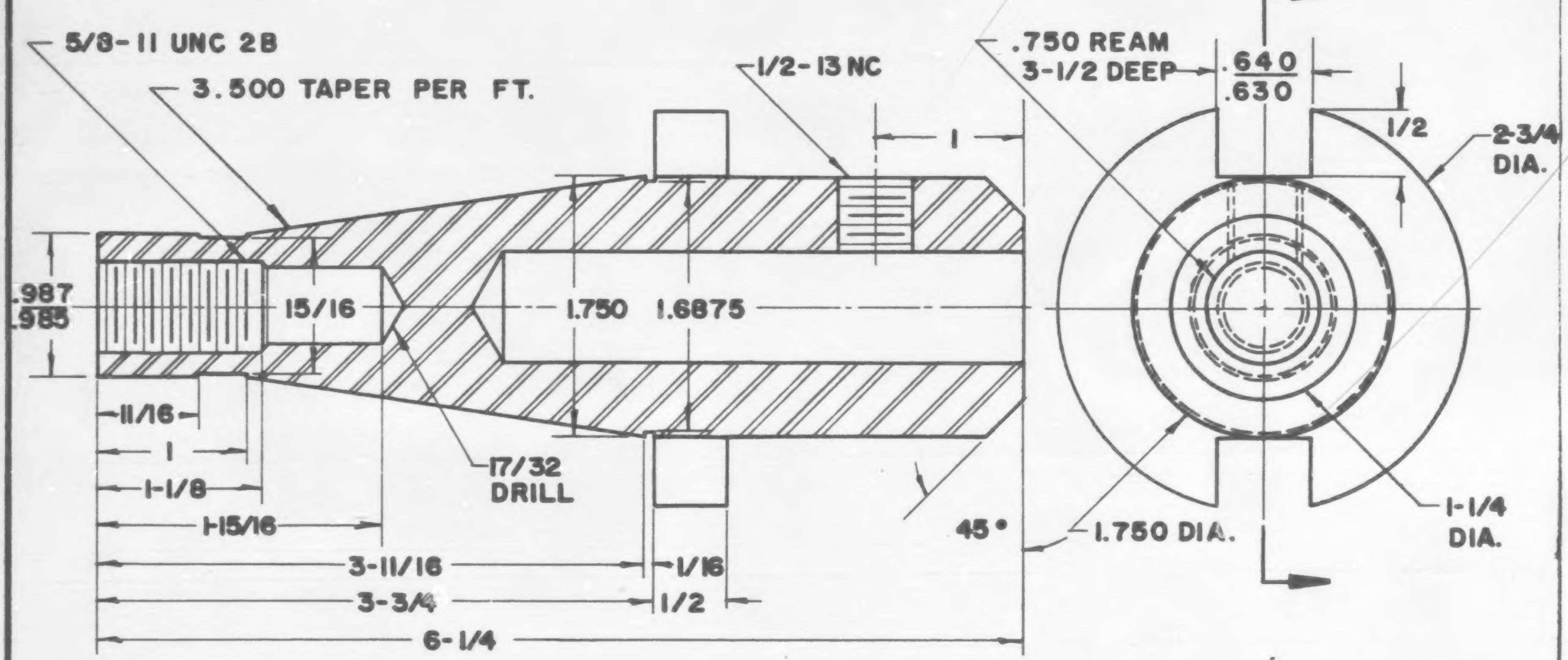
MILLING ARBOR #40 - 3/4"

PROJECT #71

COURSES: Drill Presses, Lathe, Milling Machines

MATERIALS: One Each - Cold Rolled Steel Round 2 3/4" diameter x 6 1/2" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 10	Center drilling in a lathe
	L - 14	Turn a shoulder on a lathe
	L - 28	Cutting a taper with the compound rest
	L - 11	Drilling in a lathe
	L - 12	Reaming in a lathe
	L - 24	Tapping in a lathe
	L - 13	Working between centers
	L - 5	Grinding a necking tool
	L - 35	Necking in a lathe
	L - 9	Turning in a lathe
	L - 29	Cutting a taper with the taper attachment
	D - 1	Drill on a drill press
	D - 7	Tapping on a drill press
	ML - 14	Indexing on a mill
	ML - 3	Slot milling on a horizontal mill



5/8-11 UNC 2B
3.500 TAPER PER FT.
1/2-13 NC
.750 REAM
3-1/2 DEEP
.640
.630
1/2
2-3/4
DIA.
1
.987
.985
15/16
1.750
1.6875
11/16
1
1-1/8
1-15/16
17/32
DRILL
3-11/16
1/16
3-3/4
1/2
6-1/4
45°
1.750 DIA.
1-1/4
DIA.

MATERIAL: CRS ROUND 2-3/4 DIA. X 6-1/2

UNLESS OTHERWISE SPECIFIED
TOLERANCES: +-1/64 · +- .002 · +-1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB CKD.			
AP'VD.			

TITLE
MILLING ARBOR 11 40-3/4

NO. 564

71

563

BRUNING 40-105

MILLING ARBOR #40 - 3/4"

PROJECT #71

SPECIAL INSTRUCTIONS: This project may be altered to satisfy the needs of other sizes of milling tapers by referring to the Machinery's Handbook for tapers national milling.

Part of this project may require basic Machine Shop skills while others may require more advanced.

PROCEDURES:

1. Check the size of the stock
2. Cut to 6 1/2" long
3. Chuck in a three-jaw chuck
4. Face
5. Center drill
6. Insert center
7. Turn to 1 3/4" diameter
8. Cut the taper
   a. Use the compound rest
9. Remove the center
10. Drill and ream the 3/4" hole
11. Cut an internal 60° included angle for a center
    a. Use an compound rest
12. Reverse ends
13. Follow procedures No. 10 - 26 of Project #68

MACHINE SHOP

PROJECT #72

LATHE ARBOR

LATHE ARBOR

PROJECT #72

COURSES: Measuring, Bench Work, Lathe, Milling Machines

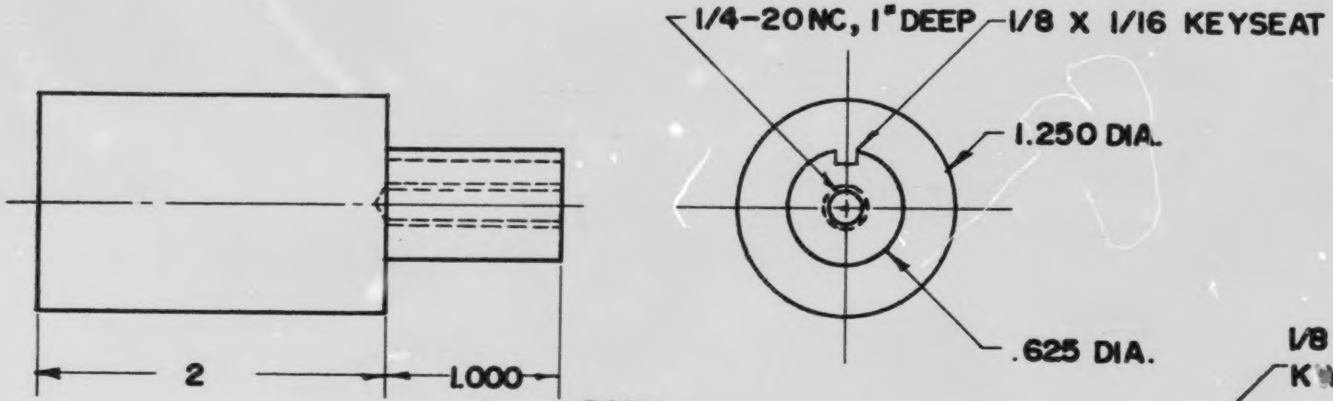
MATERIALS: One Each - Cold Rolled Steel Round 1¼" diameter x 5" long

One Each - Cold Rolled Steel Round 1" diameter x 1½" long

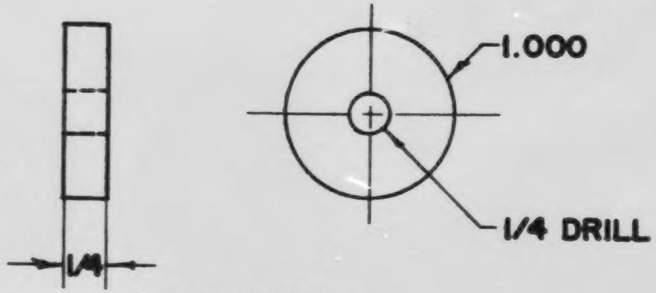
One Each - ¼" - 20 NC x 1" long Hex Head Bolt

TASK:

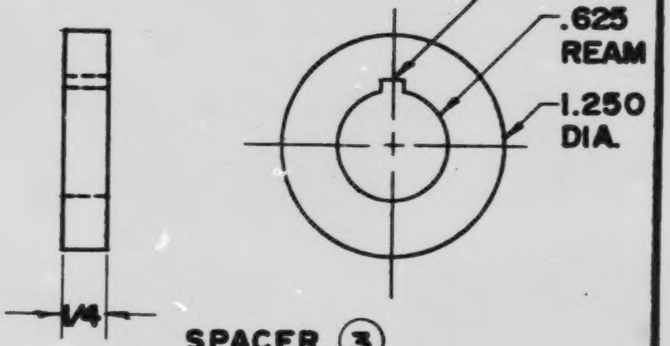
L - 6	Chucking in a three- jaw chuch
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
M - 17	Measuring with an inside caliper using a micrometer
L - 16	Cutting off in a lathe
B - 11	Using a broach
B - 10	Using an arbor press
M - 42	Using a surface plate
M - 35	Measuring with a vernier height gage
L - 7	Chucking in a four-jaw chuck
M - 41	Using a dial indicator
L - 14	Turning a shoulder on a lathe
L - 26	Using a micrometer stop
L - 24	Tapping in a lathe
ML - 9	Keyseat milling a vertical milling machine


1/4-20 NC, 1" DEEP
1/8 X 1/16 KEYSEAT
1.250 DIA.
.625 DIA.
2
1.000

BODY 1


1.000
1/4 DRILL
1/4

WASHER 2


1/8 X 1/16
KWY
.625
REAM
1.250
DIA.
1/4

SPACER ③

TOLERANCES: + - 1/64 - .002

NO.	REQ.	NAME AND OR SIZE	MAT.
4	1	1/4-20 NC X 1 HEX HD. SCREW (NOT SHOWN)	
3	3	1-1/4 DIA. X 1/4 (TO BE CUT FROM BODY STOCK)	
2	1	1 DIA. X 1-1/2	CRS
1	1	1-1/4 DIA. X 5	CRS

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD			
AP'VD.			
TITLE LATHE ARBOR		NO. 72	

BRUNING 105

LATHE ARBOR

PROJECT #72

SPECIAL INSTRUCTIONS: This arbor may be made to different shaft diameters and with other sizes of keyways to suit the need.

Part of this project may be constructed with present skills while other parts may require advanced skills.

PROCEDURES: Spacers

1. Check the stock size
2. Cut to stock to 5" long
3. Chuck the stock in a lathe
    a. Use a three-jaw chuck
4. Face one end
5. Center drill
6. Drill using the tail stock rule
    a. Drill 2 3/4" deep
        (1) From the point of the drill
        (2) Use a ¼" pilot drill
    b. Drill with the proper drill for reaming the .625 diameter
7. Ream
    a. Check the hole size
        (1) Use an inside caliper and a micrometer
8. Cut the spacers to length
    a. Use a cut-off tool
9. Broach the keyway in the spacers
    a. Use a keyway in the spacers
    b. Use an arbor press

570

BODY

10. With the stock still in the lathe, face smoothe

11. Remove from the lathe and layout the 2" from the faced end

    a. Use a surface plate

    b. Use a vernier height gage

12. Chuck in a four-jaw chuck

    a. True the stock

        (1) Use a dial indicator

13. Turn the .625 diameter to the shoulder

    a. Face the shoulder to the layout line

14. Face the .625 diameter to 1.000 length

    a. Use a micrometer stop

    b. Check with a micrometer depth gage

15. Drill with the tap drill

16. Tap to depth

17. Mount on a vertical milling table

    a. Use the T-slot as a V-block

    b. Use a flat strap and step blocks

18. Mill the keyway

    a. Check the depth before removing

WASHER

19. Check the stock size

20. Cut to 1½" length

21. Chuck in a three-jaw chuck

22. Face

23. Center drill

24. Drill

25. Cut to length

571

    a. Use a cut-off tool

26. Assemble the washer, screw and body
    a. Tighten the screw
27. Chuck in a four-jaw chuck and true
28. Center drill the screw head
    a. Use a #3 center drill
29. Round a key to fit the keyway
30. Debur all parts
31. Assemble

572

MACHINE SHOP

PROJECT #73

SOFT FACED HAMMER

573

SOFT FACED HAMMER

PROJECT #73

COURSES: Measuring, Bench Work, Drill Presses, Lathe

MATERIALS:

One each - Brass Free Machining Round 1" diameter x 3¼" long

One each - Cold Rolled Steel Round 1" diameter x 7 5/8" long

One each - #3 Tapered Pin

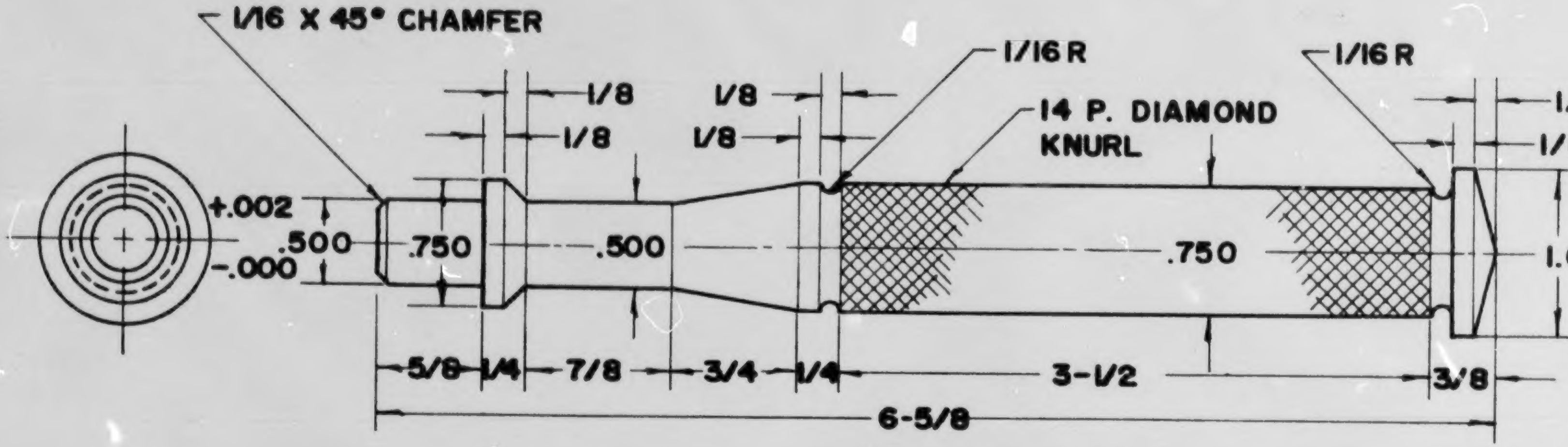
TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
M - 18	Measuring with a radius and fillet gage
M - 6	Measuring with the block and rule method
L - 36	Cutting on a drill press
D - 8	Center drilling on a drill press
D - 1	Drilling on a drill press
D - 2	Reaming on a drill press
D - 6	Spot-facing on a drill press
L - 13	Working between centers
L - 9	Turning in a lathe
L - 34	Using a follow rest on a lathe
L - 35	Necking in a lathe
L - 28	Cutting a taper with the compound rest
L - 14	Turning a shoulder on a lathe
L - 30	Cutting a taper by off-setting the tailstock
L - 15	Knurling on a lathe
B - 10	Using an arbor press
B - 9	Using a hand reamer

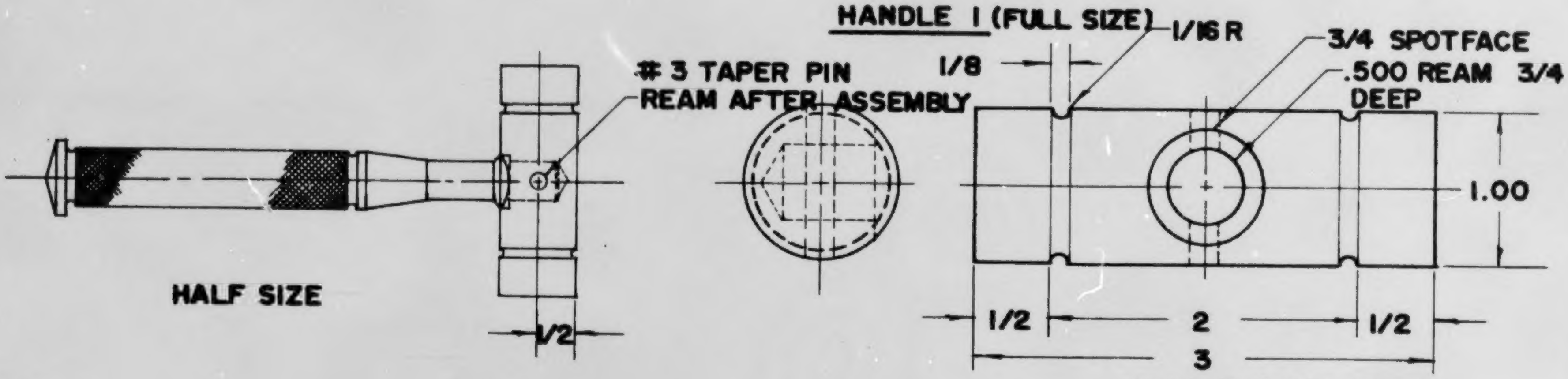
574

B - 5 Using a hand hacksaw

B - 6 Using a file


1/16 X 45° CHAMFER
1/8
1/8
1/8
1/8
1/16 R
14 P. DIAMOND KNURL
1/16 R
1/8
1/8
+.002
.500
-.000
.750
.500
.750
1.00
5/8
1/4
7/8
3/4
1/4
3-1/2
3/8
6-5/8

HANDLE 1 (FULL SIZE)


# 3 TAPER PIN
REAM AFTER ASSEMBLY
1/2
1/16 R
1/8
3/4 SPOTFACE
.500 REAM 3/4 DEEP
1.00
1/2
2
1/2
3

HALF SIZE

HEAD 2 (FULL SIZE)

TOLERANCES: +- 1/64 · +-.002 · +-1°

NO.	REQ.	NAME AND OR SIZE	MAT.
3	1	# 3 TAPERED PIN	CRS
2	1	1 DIA. X 3-1/4 ROUND FREE MACHINING	BRASS
1	1	1 DIA. X 7-5/8 ROUND	CRS

SCALE AS SHOWN
DATE
DR'N GWB
CKD.
AP'VD.

REVISIONS	BY	DATE

TITLE SOFT FACED HAMMER
NO. 73

SOFT FACED HAMMER

PROJECT #73

SPECIAL INSTRUCTIONS: Math will be required to calculate the angles.

PROCEDURES: **HEAD**

1. Check the stock size
2. Cut to 3¼" long
3. Chuck in a lathe
   a. Use a three-jaw chuck
4. Face one end and chamfer
5. Grind a form tool
   a. Use a radius and fillet gage
6. Cut the groove
7. Remove from the lathe
   a. Layout from the face end using the block and rule method
      (1) Length
      (2) Second groove
      (3) Hole location
8. Chuck in a three-jaw chuck
9. Face to length and chamfer
10. Cut second radius
11. Mount in a drill press
    a. Center punch the hole location
    b. Make sure the center punch is exactly or top
12. Center drill
13. Drill and ream
    a. Check hole size with an inside micrometer caliper

14. Spot face

HANDLE

15. Check the stock size

16. Cut to 7 5/8" long

17. Face and center drill both ends

    a. Face to 7½"

18. Mount btween centers

19. Turn the .750" diameter 6 3/8" long

    a. Use a follow rest

20. Cut the .500" diameter

21. Cut the sharp angle

    a. Use a necking tool to depth

    b. Use the compound rest

22. Cut the .500" diameter between the tapers

23. Cut the long taper

    a. Off-set the tailstock

24. Cut the radii

25. Chuck in a three-jaw chuck

26. Knurl

    a Use a tailstock center

27. Cut to length allow 1/8" for facing

28. Chuck in a three-jaw chuck on knurls

    a. Use false jaws

29. Face to length

30. Cut the angle on the end

31. Assemble head and handle

    a. Use an arbor press if required

32. Drill for taper pin

579

33. Ream for taper pin
    a. Use a hand reamer
34. Drive taper pin secure
35. Cut taper pin flush with head
    a. Use a hand hacksaw
    b. Use a file

MACHINE SHOP

PROJECT #74

ACME THREAD/BORING TOOL

581.

ACME THREAD/BORING TOOL

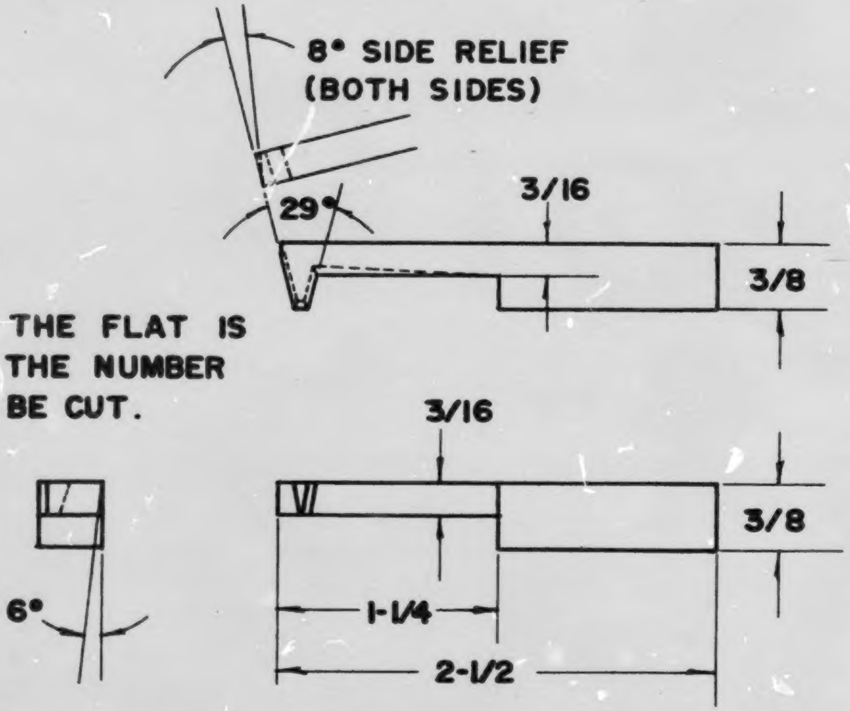
PROJECT #74

COURSES: Measuring, Grinding

MATERIALS: One Each - 3/8" Square HSS Tool Bit

TASK:

G - 1	Dressing the wheel for grinding
G - 8	Aligning work to be ground
M - 41	Using a dial indicator
G - 9	Grinding a roughing cut
G - 11	Grinding a universal angle vise
G - 3	Grinding an angle on a tool and cutter grinder
G - 10	Grinding a finishing cut
M - 21	Using an acme thread gage
G - 12	Center the wheel head
G - 2	Off-hand grinding
M - 15	Measuring with an outside caliper
M - 3	Measuring with short length rule and holder
M - 39	Measuring with a vernier bevel protractor


8° SIDE RELIEF
(BOTH SIDES)
29°
3/16
3/8
3/16
3/8
6°
1-1/4
2-1/2

NOTE: THE WIDTH OF THE FLAT IS DETERMINED BY THE NUMBER OF THREADS TO BE CUT.

MATERIAL I EA. 3/8 SQUARE HIGH SPEED STEEL TOOL BIT. TOLERANCES: +−1/64· +−1/2°

583

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD.			
AP'VD.			

TITLE ACME THREAD / BORING TOOL

NO. 584

74

BRUNING 40-105

ACME THREAD/BORING TOOL

PROJECT #74

SPECIAL INSTRUCTIONS: This project may be ground on a tool and cutter grinder or ground on a bench grinder. The first set of procedures will be for use of the tool and cutter grinder. The second set will be for the bench grinder. Grind an 8 pitch tool to be used with Project #75.

PROCEDURES: T. & C. GRINDER

1. Mount a plain wheel on the T. & C. Grinder
    a. True and dress the wheel
2. Align the A universal angle vise
    a. Use a dial indicator
3. Mount the tool in the vise so the precut angle may be used as a clearance angle
4. Rough the groove to 1¼" long leaving ¼" on the end and a 3/16" bar
5. Turn the tool 90° in the vise
6. Rough grind the bottom 1¼" long
7. Turn the tool back 90° to the original position
8. Swivel the vice so the inside angles may be cut by plunge grinding
9. Finish grind these two angles
10. Swivel the vice so the outside angles may be cut
11. Finish grind these two angles
    a. Check the angles
        (1) Use an acme thread gage
    b. Be sure the point width is smaller than needed
        (1) Use an acme thread gage

12. Zero the vice

13. Center the wheel head at the top of the tool

14. Lower the wheel head to cut the 6° end clearance angle

15. Cut the angle and the proper width of the nose of the tool
    - a. Check with an acme thread gage

BENCH GRINDER

1. Dress the wheel

2. Rough grind the bottom of the tool 1¼" long
    - a. Check the 3/16" with an outside caliper

3. Grind the groove
    - a. Leave ¼" on the end 3/16" deep
        - (1) Check with a short length rule and holder

4. Grind the inside cutting edge and clearance angles
    - a. Check the angle with an acme gage

5. Grind the outside cutting edge and clearance angles
    - a. Grind the point width smaller than needed
    - b. Check point width and angles
        - (1) Use an acme thread gage

6. Grind the end clearance and point width
    - a. Check with an acme thread gage

7. Check all clearance angles
    - a. Use a vernier bevel protractor

MACHINE SHOP

PROJECT #75

SCREW JACK/INDEXING STEADY REST

587

SCREW JACK/INDEXING STEADY REST

PROJECT #75

COURSES: Measuring, Bench Work, Drill Presses, Lathe, Milling Machines, and Grinders

MATERIALS: One Each - Cold Rolled Steel Round 1" diameter x 6" long

One Each - Cold Rolled Steel Round 2" diameter x 1 5/8" long

One Each - Cold Rolled Steel Round 2½" diameter x 3¼" long

Two Each - Allen Head Set Screws Cone Point 10-32 NF

One Each - Roll Pin 1/8" x 1" long

TASK:

L - 8	Facing in a lathe
ML - 1	Aligning a vice on a milling machine
M - 41	Using a dial indicator
ML - 3	Slot milling on a horizontal milling machine
ML - 8	Angle milling on a horizontal milling machine
ML - 13	Slitting and parting
L - 6	Chucking in a three-jaw chuck
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
L - 9	Turning in a lathe
L - 2	Grind a roughing lathe tool
L - 14	Turning a shoulder on a lathe
L - 5	Grind a necking tool
L - 35	Necking in a lathe
L - 21	Grinding a threading tool
L - 28	Cutting a taper with the compound rest

MACHINE SHOP

PROJECT #75

SCREW JACK/INDEXING STEADY REST

589

SCREW JACK/INDEXING STEADY REST

PROJECT #75

COURSES: Measuring, Bench Work, Drill Presses, Lathe, Milling Machines, and Grinders

MATERIALS:

One Each - Cold Rolled Steel Round 1" diameter x 6" long

One Each - Cold Rolled Steel Round 2" diameter x 1 5/8" long

One Each - Cold Rolled Steel Round 2½" diameter x 3¼" long

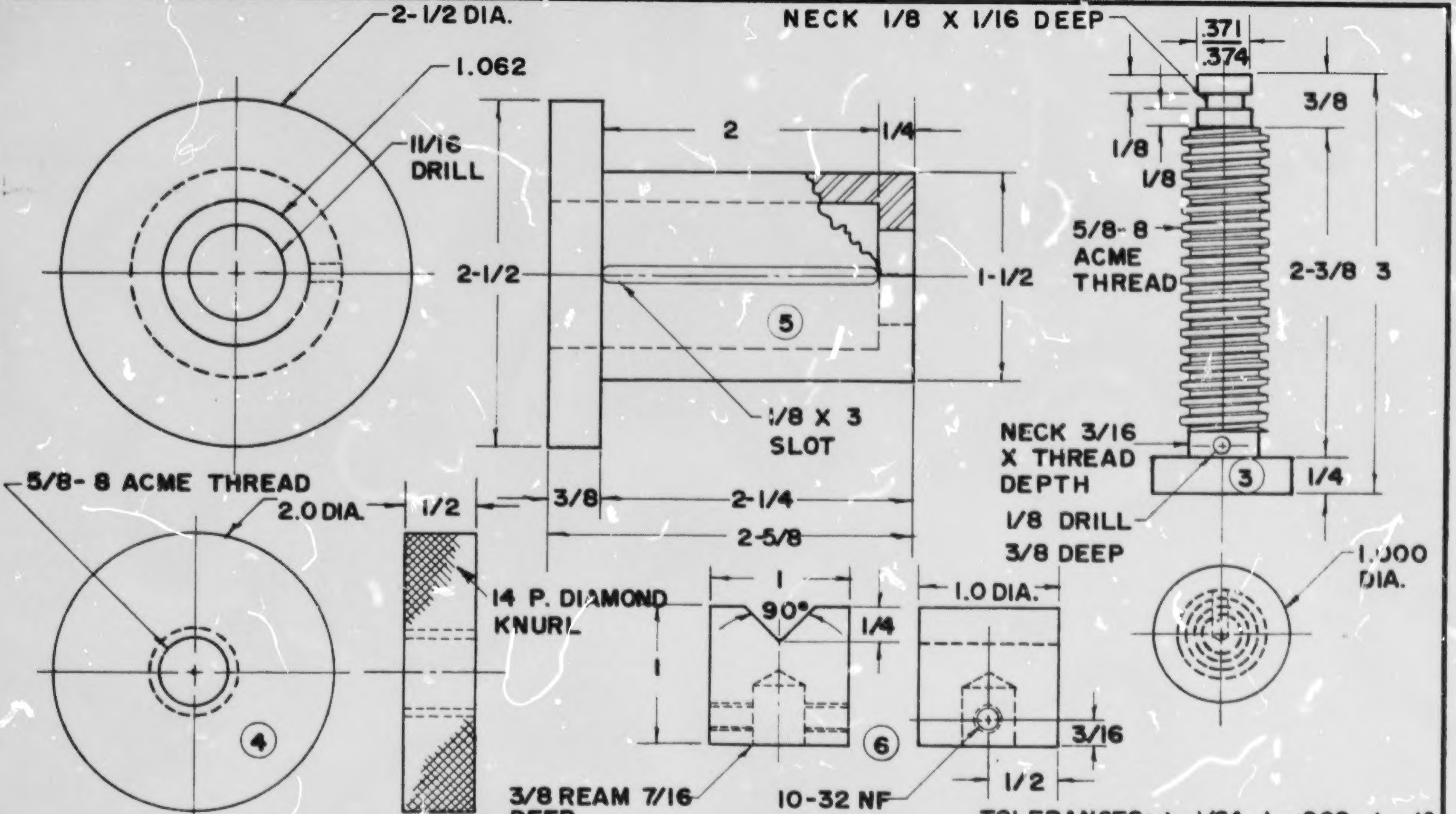
Two Each - Allen Head Set Screws Cone Point 10-32 NF

One Each - Roll Pin 1/8" x 1" long

TASK:

L - 8	Facing in a lathe
ML - 1	Aligning a vice on a milling machine
M - 41	Using a dial indicator
ML - 3	Slot milling on a horizontal milling machine
ML - 8	Angle milling on a horizontal milling machine
ML - 13	Slitting and parting
L - 6	Chucking in a three-jaw chuck
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
L - 9	Turning in a lathe
L - 2	Grind a roughing lathe tool
L - 14	Turning a shoulder on a lathe
L - 5	Grind a necking tool
L - 35	Necking in a lathe
L - 21	Grinding a threading tool
L - 28	Cutting a taper with the compound rest

M - 21	Using an acme thread gage
L - 25	Cutting an acme thread
D - 1	Drilling on a drill press
L - 7	Chucking in a four-jaw chuck
L - 33	Using a steady rest on a lathe
L - 31	Boring in a lathe
D - 8	Center drilling on a drill press
D - 3	Boring on a drill press
M - 31	Measuring with an inside micrometer caliper
M - 33	Measuring with a micrometer depth gage
ML - 5	End Milling
ML - 2	Slot milling on a vertical milling machine
L - 15	Knurling on a lathe
L - 23	Cutting internal threads in a lathe
G - 4	Grinding a flat on a surface grinder
G - 13	Grinding on a magnetic chuck
L - 32	Using a face plate
B - 6	Using a file
B - 9	Using a hand reamer
B - 10	Using an arbor press
B - 3	Using allen wrenches


2-1/2 DIA.
1.062
11/16 DRILL
2-1/2
2
1/4
1-1/2
5
1/8 X 3 SLOT
NECK 1/8 X 1/16 DEEP
.371
.374
3/8
1/8
1/8
5/8-8 ACME THREAD
2-3/8
3
NECK 3/16 X THREAD DEPTH
3
1/4
1/8 DRILL 3/8 DEEP
5/8-8 ACME THREAD
2.0 DIA.
1/2
3/8
2-1/4
2-5/8
14 P. DIAMOND KNURL
4
1
90°
1/4
1
6
1.0 DIA.
3/16
1/2
3/8 REAM 7/16 DEEP
10-32 NF
1.000 DIA.

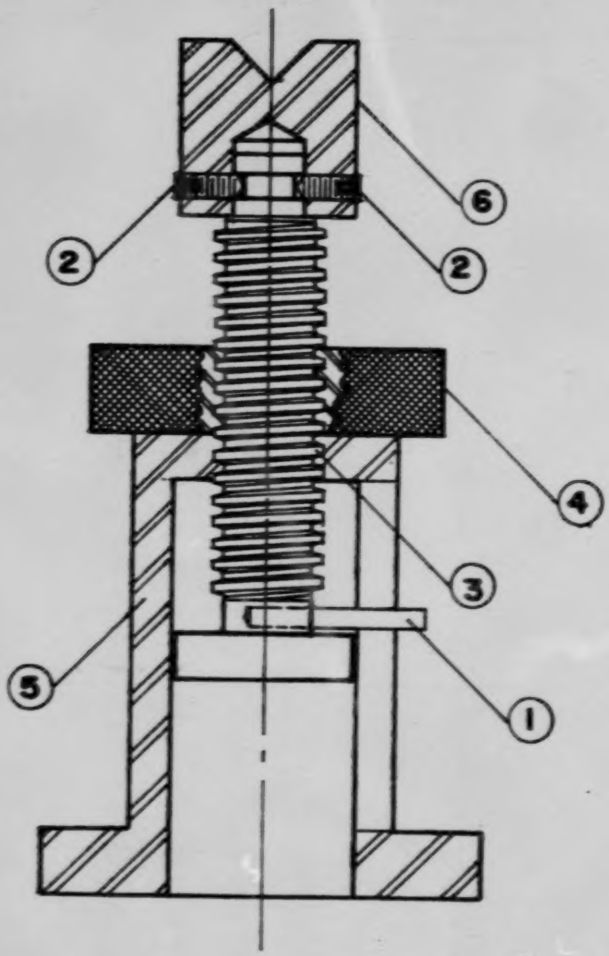
TOLERANCES: +-1/64 · +-.002 · +-1°

NO.	REQ.	NAME AND OR SIZE	MAT'L
6	1	SWIVAL REST (CUT FROM NO. 3 PART)	CRS
5	1	ROUND 2-1/2 X 3-1/4 BODY	CRS
4	1	ROUND 2- X 1-5/8 ELEV. NUT	CRS
3	1	ROUND 1 X 5 SCREW	CRS
2	2	ALLEN HD. SET SCREWS CONE PT. 10-32 NF	
1	1	1/8 DIA. X 1 ROLL PIN	

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB	CKD		
AP'VD			

TITLE SCREW JACK / INDEXING STEADY REST

NO. 1 OF 2 75



SCALE FULL		REVISIONS	BY	DATE
DATE				
DR'N. GWB	CKD.			
AP'VD.				
TITLE SCREW JACK ASSEMBLY		NO. 2 OF 2 75		

SCREW JACK/INDEXING STEADY REST

PROJECT #75

SPECIAL INSTRUCTIONS: Part of this project may require advanced machining skills. Several methods of machining will be covered to satisfy application of different task.

PROCEDURES: Swivel Rest

1. Check the stock size 1" diameter
2. Cut to 6" long
3. Face the stock in a lathe and chamfer one end
4. Mount in a milling horizontal mill
    a. Use a vise
        (1) True the vise jaws parallel to the arbor
        (2) Use a dial indicator
5. Mount the stock vertically in the vise faced end up
    a. Use V-blocks in the vise to secure the stock
6. Mount an angle milling cutter on the arbor
7. Center the cutter over the stock
8. Cut the angle groove to depth
9. Cut to 1 1/8" length
    a. The remainder of the stock will be used for the screw
    b. Use a cut-off saw on the mill
    c. Turn the stock horizontally in the vise
10. Cut-off
11. Face to length in a lathe
    a. Use a three-jaw chuck
12. Center drill, drill and ream

595

13. Remove from the lathe

14. Drill and tap the 10-32 NF set screw holes

Screw

15. Mount in a lathe
    a. Use a three-jaw chuck
    b. Chuck on 1¼"
16. Face and center drill
17. Insert a tailstock center
18. Turn the 5/8" diameter to length
    a. Grind a roughing tool
    b. Rough cut and finish cut to .625"
19. Turn the .123" and face the shoulder
20. Neck the groove
    a. Use a cut-off tool
21. Neck the 3/16" groove
23. Grind an acme threading tool
24. Turn the compound rest 14½° to the right
25. Center the tool
    a. Use an acme thread gage
26. Cut the thread
27. Remove from the lathe
28. Cut to length
    a. Allow 1/8" for facing
29. Chuck on thread
    a. Use a three-jaw chuck
30. Face to length
31. Drill the roll pin hole

596

Body

32. Check the stock size 2½" diameter
33. Cut to 3¼" long
34. Chuck in a lathe
    a. Use a four-jaw chuck
        (1) Chuck on ½"
    b. True the stock
        (1) Use a dial indicator
35. Face
    a. Use a steady rest
36. Center drill
37. Turn the 1½" diameter 2¼" long
    a. Face the shoulder
38. Cut to 2 7/8" long
39. Face in a lathe
    a. Use false jaws

Lathe - (Optional)

40. After facing true the stock
    a. Use a four-jaw chuck
    b. Use a dial indicator
41. Center drill
42. Drill through
    a. Use 11/32" drill
43. Bore the diameter
    a. Check with an inside micrometer caliper

Drill Press - (Optional)

44. Mount on a drill press

    a. True the stock
    b. Use a dial indicator
45. Center drill
46. Drill through
    a. Use 11/32" drill
47. Bore the diameter
    a. Check with an inside micrometer caliper
    b. Check the depth with a micrometer depth gage
48. True a vice on a vertical mill
    a. Use a dial indicator
49. Mill the slot
    a. Use an end mill

Elevating Nut

50. Check the stock size 2" diameter
51. Cut to 1 5/8" long
52. Chuck in a three-jaw chuck
53. Face
54. Center drill
    a. Insert a tailstock center
55. Knurl
56. Remove center
57. Drill to minor diameter of threads size
58. Chamfer with a 60° counter sink
59. Grind an acme threading/boring tool
    a. See Project #74

Continue working in a three-jaw chuck

60. Swing the compound 14½° to the left
61. Center the tool

    a. Use an acme thread gage

62. Cut the thread
    a. Cut an internal groove 5/8" in the hole to thread depth
        (1) To allow the tool to drop into so not to damage the tool
        (2) Disengage half-nut lever when tool is in the groove
    b. Use the screw to insure proper fit

63. Cut the stock to length
    a. Allow 1/8" for facing

64. Face to length

Face Plate Method

65. Cut to 5/8" length
    a. Allow for facing

66. Mount on a surface grinder
    a. Use a magnetic chuck

67. Grind to width
    a. Check with a micrometer depth gage

68. Mount on a face plate
    a. Use a center in the tailstock to align the hole
    b. Clamp on the face plate

69. Swing the compound 14½° to the left

70. Center the tool
    a. Use an acme thread gage

71. Cut the thread
    a. Use the screw as a thread plug gage

Assembly

1. Debur all parts

599

    a. Use a file
    b. Use a hand reamer
2. Insert screw in the bottom of the body
3. Press roll pin in drilled hole through slot
    a. Use an arbor press
4. Screw elevating nut onto screw
5. Mount and adjust tightness of swivel rest on screw
    a. Use set screws
    b. Use allen wrenches

600

MACHINE SHOP

PROJECT #76

LATHE CHUCK WRENCH

601

LATHE CHUCK WRENCH

PROJECT #76

COURSES: Lathe, Milling Machines

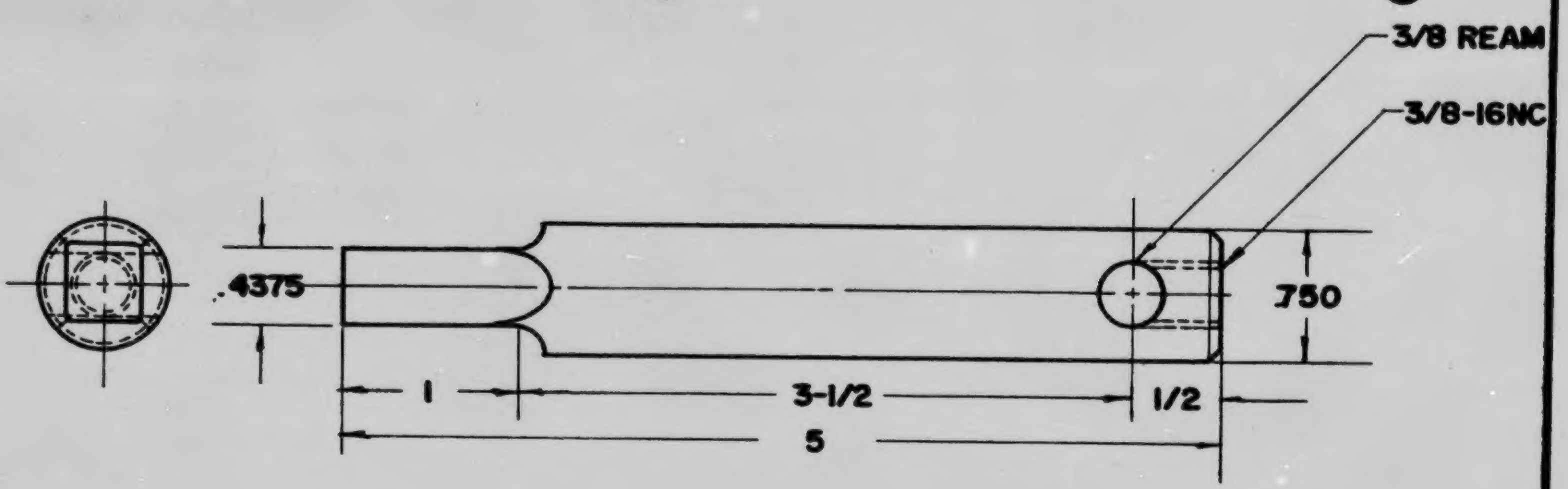
MATERIALS: One Each - SAE 1045 Steel Round, 3/4" diameter x 5¼" long
(CRS may be used and case hardened)

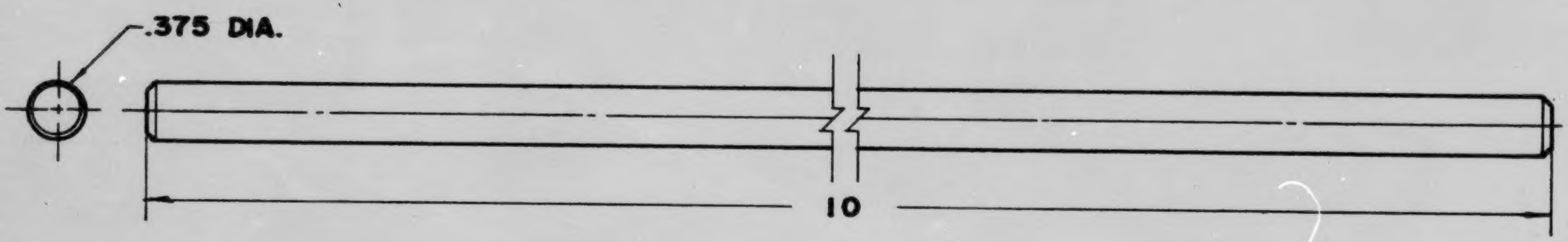
One Each - Cold Rolled Steel Round 3/8" diameter x 10¼" long

One Each - Allen Head Set Screws 3/8"-16 NC x 5/16" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 11	Drilling on a lathe
L - 24	Tapping in a lathe
L - 14	Turning a shoulder on a lathe
ML - 1	Aligning a vice on a milling machine
ML - 4	Plain milling
ML - 14	Indexing on a milling machine


3/8 REAM
3/8-16NC
.4375
.750
1
3-1/2
1/2
5



NOTES:

1. CHAMFER ALL EDGES 1/16 X 45°
2. GRIND AFTER HEAT TREATING.

TOLERANCES: +-1/64 · +-.002

NO.	REQ.	NAME AND OR SIZE	MAT.
3	1	ALLEN HD. SET SCREW 3/8-16 NC X 5/16	
2	1	3/8 DIA. X 10-1/4 ROUND	CRS
1	1	SAE 1045 STEEL ROUND 3/4 DIA. X	5-1/4

603

SCALE FULL	REVISIONS	BY	DATE
DATE			
DRN GWB / CKD			
APVD.			

TITLE LATHE CHUCK WRENCH

NO. 604

76

LATHE CHUCK WRENCH

PROJECT #76

SPECIAL INSTRUCTIONS: Cold rolled steel may be used and case hardened.

PROCEDURES:

1. Check the stock size
2. Cut to 5¼" long
3. Drill the 3/8" hole 9/16" from the end
4. Chuck in a lathe
    a. Use a three-jaw chuck
5. Face until the 3/8" hole is ½" from the end
6. Center drill
7. Drill and tap
8. Chamfer
9. Reverse ends
10. Face to length
11. Center drill
    a. Use a #3 center drill
12. Turn to .6187" diameter 1" long
    a. Face the shoulder
    b. Chamfer
13. Mount a dividing head on a horizontal mill
    a. True the dividing head
14. Mount the stock in the dividing head
    a. Chuck on 1½"
    b. Insert the foot stock
15. Mill one flat
    a. Check stock removal with an outside micrometer

16. Index

17. Mill second flat

18. Index

19. Mill the third flat

    a. Check to insure 7/16"

20. Index

21. Mill the fourth side

22. Remove and heat treat

Handle

23. Cut the 3/8" diameter stock 10¼" long

24. Chuck in a three-jaw chuck

25. Face and chamfer both ends

Assemble

26. Insert handle in hole

27. Tighten allen head cap screws

MACHINE SHOP

PROJECT #77

INTERNAL PIPE WRENCH (1 INCH)

607

INTERNAL PIPE WRENCH (1 INCH)

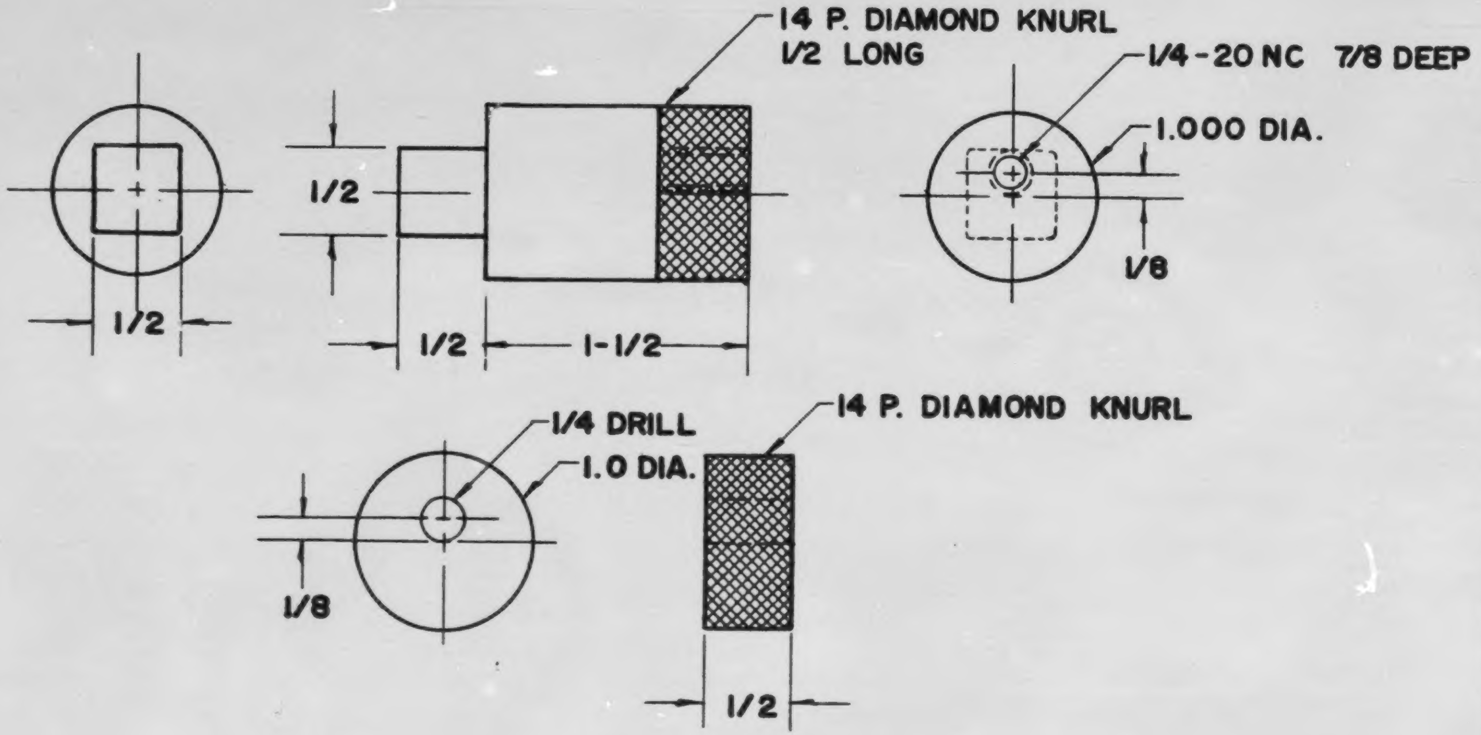
PROJECT #77

COURSES: Measuring, Bench Work, Lathe, Milling Machines

MATERIALS: One Each - SAE 1045 Steel Round 1" diameter x 3¼" long

One Each - Round Head Machine Screw ¼"-20 NC 1½" long

TASK:	L - 7	Chucking in a four-jaw chuck
	L - 8	Facing in a lathe
	L - 15	Knurling on a lathe
	M - 41	Using a dial indicator
	L - 10	Center drilling in a lathe
	L - 38	Cutting a cam in a lathe
	L - 11	Drilling in a lathe
	L - 16	Cutting-off in a lathe
	L - 24	Tapping in a lathe
	L - 14	Turning a shoulder on a lathe
	ML - 14	Indexing on a milling machine
	ML - 5	End milling
	B - 4	Using a screwdriver


14 P. DIAMOND KNURL
1/2 LONG
1/4-20 NC 7/8 DEEP
1.000 DIA.
1/8
1/2
1/2
1/2
1-1/2
1/4 DRILL
1.0 DIA.
14 P. DIAMOND KNURL
1/8
1/2

MATERIALS: 1 EA. SAE 1045 STEEL ROUND 1 DIA. X 3-1/4
1 EA. 1/4-20 NC ROUND HD. MACHINE
SCREW 1-1/2 LONG.

TOLERANCES: +-1/64 · +- .002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB · CKD.			
AP'VD.			
TITLE INTERNAL PIPE WRENCH (1 INCH)		NO. 610 77	

609

INTERNAL PIPE WRENCH (1 INCH)

PROJECT #77

SPECIAL INSTRUCTIONS: Part of this project may require advanced machining skills. Both parts will be made in one operation to conserve time and materials.

PROCEDURES:

1. Check the stock size
2. Cut the stock 3¼" long
3. Chuck in a lathe
    a. Use a four-jaw chuck
        (1) True the stock with a dial indicator
    b. Chuck on 1½"
4. Face one end
5. Knurl
    a. 1 1/8" long
6. Set up a dial indicator
    a. Zero the indicator
        (1) The indicator must have more than .250" travel
        (2) Depress the indicator at least .135", then zero
        (3) Have #1 jaw in alignment with the indicator
7. Turn the chuck by hand and loosen #3 jaw
8. Turn the chuck by hand and tighten #1 jaw
    a. Move the stock .126"
9. Remove the indicator
10. Turn the chuck to #3 jaw
    a. Set-up the indicator
11. Tighten #3 jaw

611

    a. Until .001" is noted

12. Zero the indicator

13. Turn the chuck slowly and observe the throw

    a. The indicator should show a travel of .250"

        (1) Make any necessary adjustments

14. Center drill the stock

15. Drill ¼" diameter 9/16" deep

16. Cut the stock ½" long

    a. Use a 1/8" wide cut-off tool

17. Face

18. Center drill

19. Drill and tap the ¼"-20 NC

20. Reverse ends

    a. Use a collet chuck

21. Face to length

22. Turn the shoulder

    a. .7071" diameter

23. Set-up in a vertical milling machine

    a. Use a indexing head

    b. True the indexing head

24. Cut the square

    a. Use a 5/8" end mill

25. Heat treat

26. Assemble

    a. Be sure the threads tighten

        (1) Use a screwdriver

    b. Leave the outer part loose

        (1) About 1/32" to 1/16" space

MACHINE SHOP

PROJECT #78

BUFFER/GRINDER SHAFT

613

BUFFER/GRINDER SHAFT

PROJECT #78

COURSES: Measuring, Lathe, Milling Machines

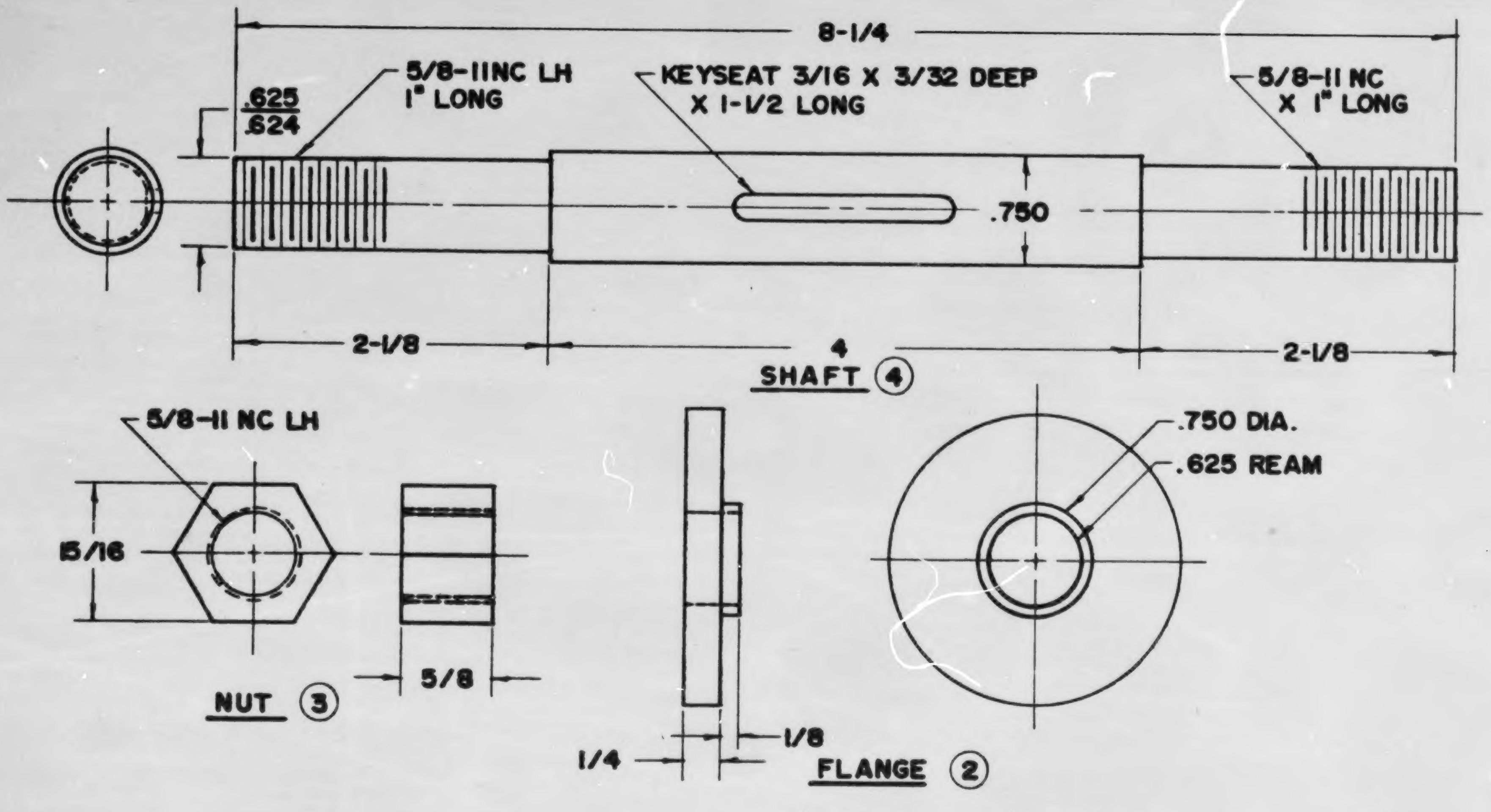
MATERIALS:

One Each - Cold Rolled Steel Round 3/4" diameter x 8½" long
One Each - Hot Rolled Steel Round 1 1/8" diameter x 3" long
One Each - Cold Rolled Steel Round 2" diameter x 3" long
One Each - 5/8"-11 NC Hex Nut

TASK:

L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 37	Chuck in a collet chuck
L - 13	Working between centers
L - 9	Turning in a lathe
L - 22	Cutting external v-threads in a lathe
M - 38	Measuring with a thread micrometer
ML - 10	Keyseat milling or a horizontal milling machine
ML- 4	Plain milling
L - 7	Chucking in a four-jaw chuck
M-41	Using a dial indicator
L - 11	Drilling in a lathe
L - 12	Reaming in a lathe
M - 31	Measuring with an inside micrometer caliper
L - 14	Turning a shoulder on a lathe
L - 26	Using a micrometer stop
M - 34	Measuring with a vernier caliper
L - 27	Using a mandrel

M - 30	Measuring with an outside micrometer caliper
L - 6	Chucking in a three-jaw chuck
ML - 6	Fly cutter/shell end milling
ML - 14	Indexing on a milling machine
L - 21	Grinding a threading tool
L - 23	Cutting internal threads in a lathe


8-1/4
5/8-11NC LH
1" LONG
KEYSEAT 3/16 X 3/32 DEEP
X 1-1/2 LONG
5/8-11 NC
X 1" LONG
.625
.624
.750
2-1/8
4
2-1/8
SHAFT ④
5/8-11 NC LH
15/16
5/8
NUT ③
.750 DIA.
.625 REAM
1/4
1/8
FLANGE ②

TOLERANCES: +-1/64 · +-.002 · = +-.001

4	1	ROUND 3/4 DIA. X 8-1/2	CRS
3	1	ROUND 1-1/8 DIA. X 3	HRS
2	1	ROUND 2 DIA. X 3	CRS
1	1	5/8-11 NC NUT RH (NOT SHOWN)	
NO.	REQ	NAME AND OR SIZE	MAT

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DR'N GWB · CKD			
AP'VD			

TITLE
BUFFER / GRINDER SHAFT

NO.

78

BUFFER/GRINDER SHAFT

PROJECT #78

SPECIAL INSTRUCTIONS: Part of this project may require advanced machining skills.

PROCEDURES: Shaft

1. Check the stock size
2. Cut the 3/4" stock to 8½" long
3. Face both ends and center drill
    a. Use a collet chuck
4. Set between centers
5. Turn the .625" diameter
6. Cut the right hand threads
    a. Check with a thread micrometer
7. Reverse ends
    a. Use false jaw to protect the thread
8. Turn to length and diameter
9. Cut the left hand threads
    a. Check with a thread micrometer
10. Mount in a horizontal mill
11. Mill the keyseat
    a. Use a plain milling cutter
    b. Check depth before removing
    c. Use the T-slots as V-blocks

Flange

12. Check the 2" diameter stock size
13. Cut 3" long
14. Chuck in a four-jaw chuck

    a. True with a dial indicator

15. Face

16. Center drill

17. Drill and ream through

    a. Check the hole with an inside micrometer caliper

18. Turn the shoulder

    a. Use a micrometer stop for the length

    b. Use a slide vernier for the diameter

19. Cut in a saw ½" long

20. Re-chuck in a four-jaw chuck and indicate the stock

21. Cut the shoulder as before

22. Cut ½" long

23. Repeat procedure until all four have been cut

24. Mount one at a time on a mandrel

25. Place between centers

26. Face to dimensions

    a. Check with an outside micrometer caliper

27. Chamfer

Nut

28. Place 1 1/8" diameter x 3" long stock in a lathe

    a. Use a three-jaw chuck

29. Face and center drill

30. Turn to 1.083" diameter

31. Place in a vertical mill

    a. Use a dividing head

    b. Use a fly cutter or a shell end mill

32. Mill the hexagonal

33. Cut to 3/4" long

    a. Use a horizontal band saw

34. Re-chuck in a three-jaw chuck

35. Face to length

36. Chamfer

37. Center drill

38. Drill for threading

39. Grind a V-threading tool similar to Project #74

40. Cut the left hand threads

    a. Use the shaft as a plug gage

Assembly

To make this a usable project, a pulley is keyed to the 3/4" shaft. Pillow block bearings are mounted to a stand on either side of the pulley. A motor is mounted to the stand driving a belt. Note the pulley ratio should not allow the shaft to exceed 3600 RPM or wheel surface feet recommendations. A flange is placed with the shoulder to the shaft. Mount a wheel, another flange and the nut. All safety features must be added-wheel guards, tool rest, spark arresters and safety shields. These features could be fabricated as part of other courses.

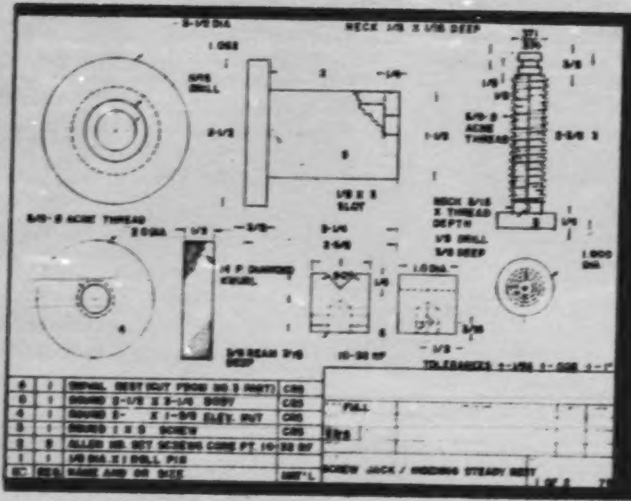
REFERENCES

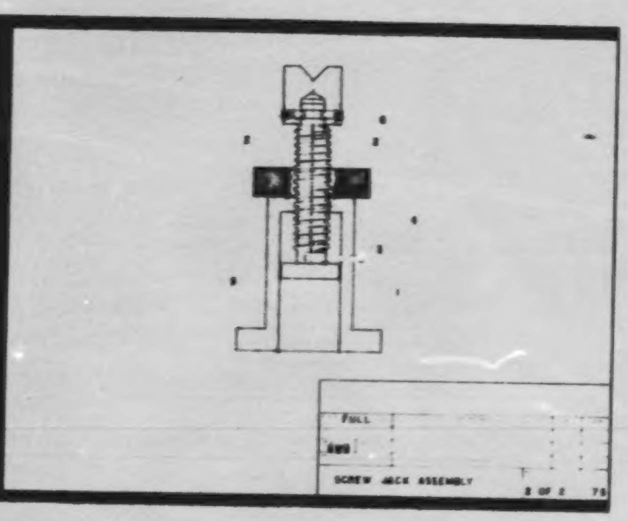
1. Krar, S. F. and Oswald, J. W.: Grinding Technology. Albany: Delmar Publishers, 1974.
2. Lascoe, Nelson, Porter: Machine Shop - Operations and Setups. Chicago: American Technical Society, 1973
3. Oberg, Erik and Jones, F. D.: Machinery's Handbook. New York, N.Y.: Industrial Press Inc., 1976
4. Morse: Machinist's Practical Guide. New Bedford, Mass: Morse Cutting Tools Division, 1978
5. Krar, S.F.; Oswald, J. W. and St. Amond, J. E.: Technology of Machine Tools. New York: McGraw-Hill Book Company, Gregg Division, 1977

MACHINE SHOP PROJECTS

SHAPER
Projects 79-81

SHAPER, GRINDER
Projects 82-84




FULL
SCREW JACK ASSEMBLY
2 OF 2

STUDENT MANUAL

Georgia Department of Education

PURPOSE

A student in Machine Shop must learn by doing. Although lectures, reading assignments, and audio-visual aids are very necessary, these methods alone will never produce a good machinist. The combination of both classroom and shop practice is essential to your training. The purpose of this Shop Project Guide is to give the necessary shop experience to complement your classroom training. This guide is based on the author's years of practical experience as a skilled machinist and as a teacher in the field. Each skill needed to complete a phase of your training has been identified. Next, projects have been devised to give hands-on experience for each skill with enough repetition so that you will become capable of using each tool or attachment for the particular machine or operation being taught. Your instructor will help you select or will assign the projects in the necessary order. You will also find the end products of these projects will be useful tools that will help in your training that follows. This serves not only to make the projects more interesting, but more enjoyable to construct. This practical training along with classroom instruction and applied learning can bring you a rewarding future as a skilled tradesman.

PROJECT LISTING (CATEGORIZED)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench

*11. Pipe flange assembly

*12. C-clamp

*13. Block and tackle

*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects

*16. Jack Stand

*17. Gear puller

18. Tool post base

624

MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (genreal purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. 1/4" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
40. Dead center
41. Plumb bob

42. Dumbbell set

43. Taper plug gage

44. Rocker dish

45. Rocker

46. Tool post body

47. Circle cutter

48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II

*50. Fly cutter

51. Tooth pick holder

*52. Pipe center

53. Taper ring gage

54. Set up bolt 1/2" x 4"

55. Set up bolt 1/2" x 6"

56. Set up bolt 1/2" x 8"

57. Set up bolt 3/8" x 4"

58. Set up bolt 3/8" x 6"

59. Drill reducer

60. Tap drill extension (1/4" - 20 NC tap drill)

61. Tap drill extension (5/16" - 18 NC tap drill)

62. Boring bar holder body jig

63. Boring bar holder body

*64. Boring bar holder base

65. Boring bar holder inner body

66. Boring bar holder base jig

67. Precision measuring tool block
*68. Milling arbor #40 - 3/8"
*69. Milling arbor #40 - 1/5"
*70. Milling arbor #40 - 5/8"
*71. Milling arbor #40 - 3/4"
*72. Lathe arbor
73. Mallet
74. Acme thread/boring tool
*75. Screw jack/indexing steady rest
76. Lathe chuck wrench
77. Internal pipe wrench
78. Buffer/grinder shaft

SHAPER

79. Splitting wedge
80. Flat strap clamp
*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks I
*83. V-blocks
84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge
86. Solid key seat
87. Water valve wrench
88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. 1/4" pitch, 1' lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

628

MACHINE SHOP

PROJECT #79

SPLITTING WEDGE

SPLITTING WEDGE

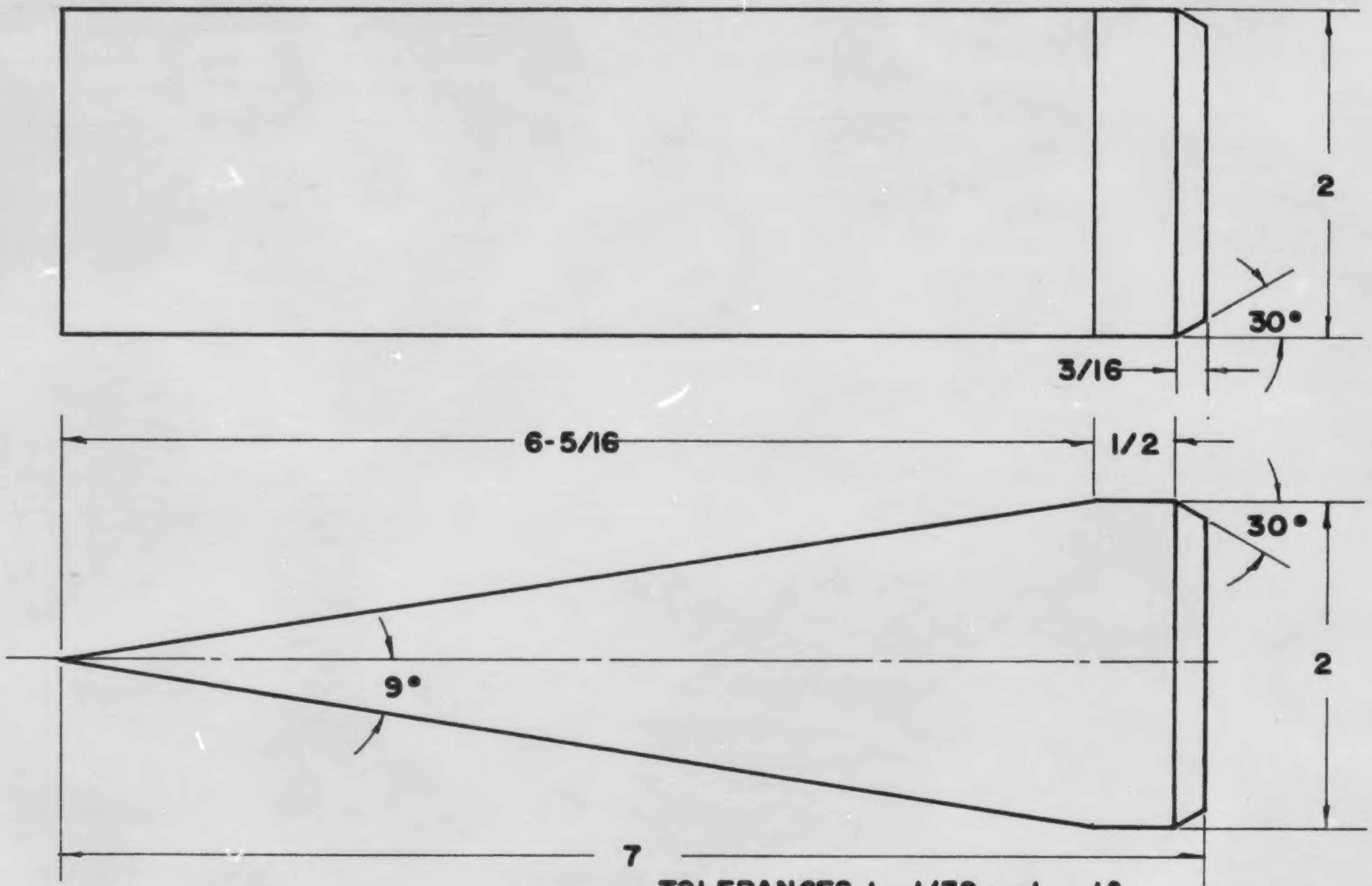
PROJECT #79

COURSES: Shaper

MATERIALS: One Each - Hot Rolled Steel Square 2" x 2" x 7¼" long

TASK:

SP - 5 Grinding a shaper tool
SP - 2 Shaping a horizontal surface
SP - 4 Shaping an angle using the head
SP - 1 Trueing a vice in a shaper
SP - 3 Shaping an angle using a vice


2
30°
3/16
6-5/16
1/2
30°
9°
2
7

TOLERANCES +- 1/32 · +- 1°

MATERIAL: 1 EA. HRS SQUARE 2 X 2 X 7-1/4

631

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB / CKD.			
AP'VD.			

TITLE SPLITTING WEDGE

NO. 632 79

BRUNING 40-105

SPLITTING WEDGE

PROJECT #79

SPECIAL INSTRUCTIONS: Time may be saved by roughing this project on a vertical band saw.

PROCEDURES:

1. Check the stock size 2' x 2"
2. Cut the stock to 7¼" long
3. Mount the stock square on the side of the table
    a. Have 1" above the table
4. Adjust the table
    a. Bring the table up
        (1) Do not have the tool holder or head too low
5. Grind a shaper tool
6. Adjust the stroke of the ram
    a. Length
    b. Position
7. Set the number of strokes
8. Shape the saw cut surface square with the sides
9. Swing the head 30°
    a. Be sure the head does not hit the ways on the return stroke
10. Cut the angles on all four sides
    a. Feed down using the hand wheel
        (1) Feed on the return stroke
11. Reverse ends and shape to length
12. Layout the long angle
13. True the shaper vice
14. Mount the stock in a shaper vice

   a. Have one layout line parallel to the top edge of the shaper vice

      (1) At least ¼" above

      (2) Use a surface gage

15. Cut the angle

16. Set-up the second angle

17. Cut the angle

18. Debur all edges

634

MACHINE SHOP

PROJECT #80

FLAT STRAP CLAMP

FLAT STRAP CLAMP

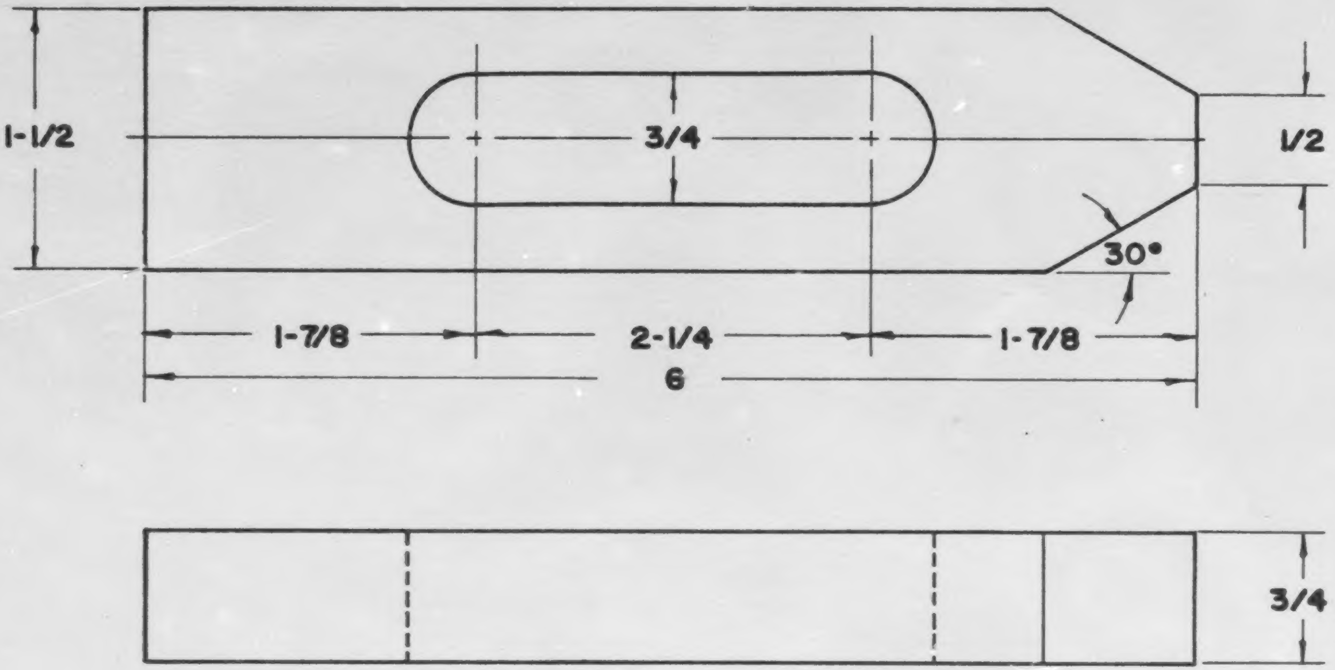
PROJECT #80

COURSES: Saws, Shapers, Milling Machines

MATERIALS: One Each - Cold Rolled Steel Flat 3/4" x 1½" x 6¼" long

TASK:

SP - 5	Grinding a shaper tool
SP - 2	Shaping a horizontal surface
SP - 1	Truing a vice in a shaper
SP - 6	Shaping a vertical surface
SP - 3	Shaping an angle using a vice
SP - 4	Shaping an angle using the head
ML - 1	Aligning a vice on a milling machine
ML - 2	Slot milling on a vertical milling machine
ML - 5	End milling
SP - 7	Slotting on a shaper
S - 4	Cutting an internal surface on the vertical bandsaw


1-1/2
3/4
1/2
30°
1-7/8
2-1/4
1-7/8
6
3/4

MATERIAL: 1 EA. CRS FLAT 3/4 X 1-3/4 X 6-1/4

TOLERANCE: + - 1/32

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB CKD			
AP'VD.			

TITLE FLAT STRAP CLAMP	NO. 638

637

80

FLAT STRAP CLAMP

PROJECT #80

SPECIAL INSTRUCTIONS: The slot may be cut on a shaper by drilling a 3/4" hole at each end and using the holes for a necking tool to start and stop the cut in. The holes may also be used for internal cutting on a vertical band saw.

PROCEDURES:

1. Check the stock size
2. Cut to 6¼" long
3. Grind a shaper tool
4. Shape both ends square
    a. Follow procedure #3 - 8 in Project #79
5. True a vice on a shaper
6. Mount the stock in the vice at a 30° angle
    a. Use a protractor
7. Cut the angle by making a vertical cut
    a. Be sure the head is straight
        (1) Use a solid square
    b. Adjust the clapper vice
8. Square the stock in the vice
9. Swing the head 30°
    a. Make sure the head does not hit the ways on the return stroke
10. Cut the angle
11. True a vice on a vertical mill
12. Mill the slot
    a. Use a 3/4" end mill
13. Debur all edges

MACHINE SHOP

PROJECT #81

PARALLEL CLAMPS

640

PARALLEL CLAMPS

PROJECT #81

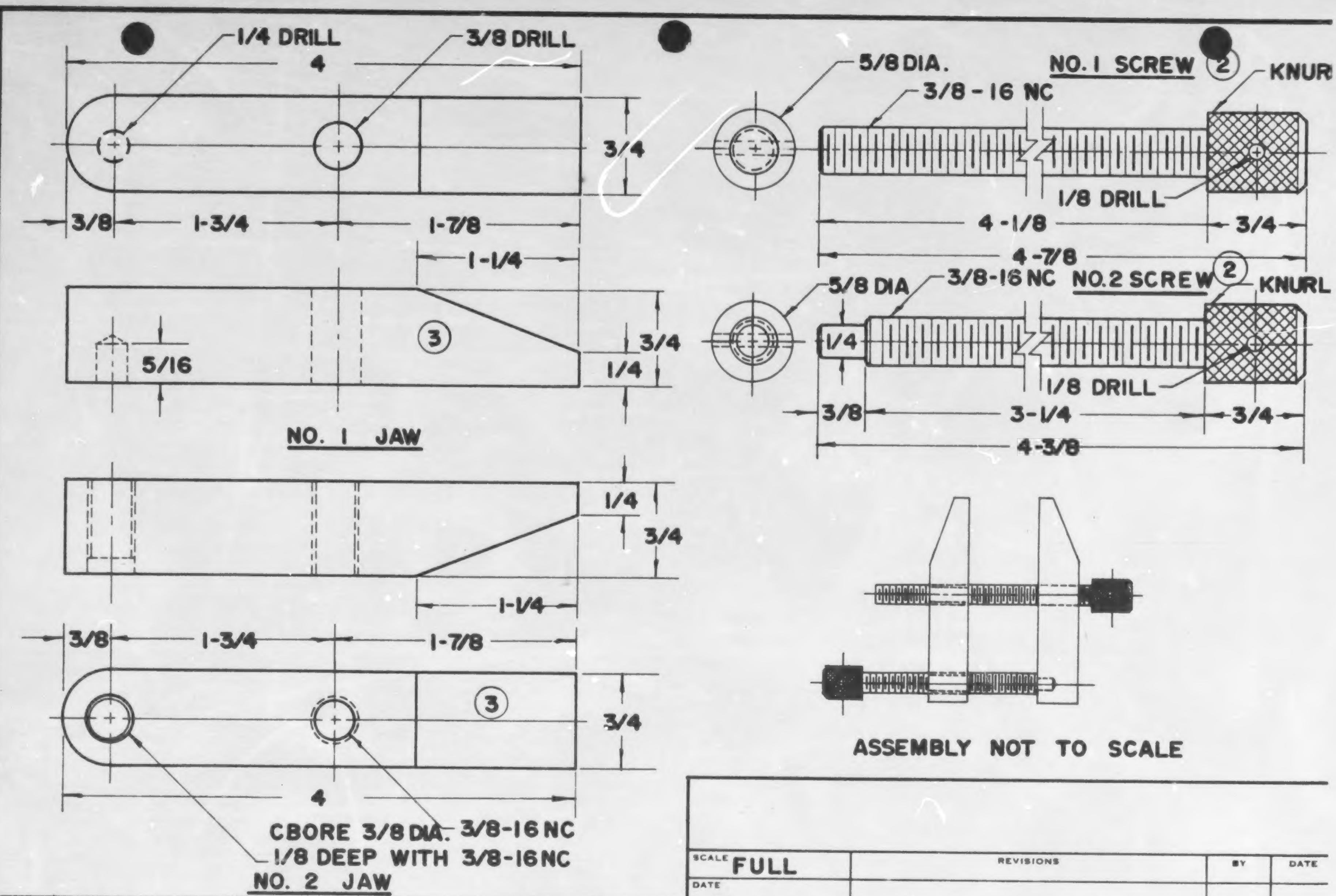
COURSES: Measuring, Saws, Drill Presses, Lathe, Shapers

MATERIALS:

Two Each - Cold Rolled Steel Round 5/8" diameter x 6½" long
Two Each - Cold Rolled Steel Square 3/4" x 3/4" x 4¼" long
Two Each - Roll Pins 1/8" diameter x 2" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 9	Turning in a lathe
L - 22	Cutting external V-threads in a lathe
M - 38	Measuring with a thread micrometer
L - 15	Knurling on a lathe
S - 1	Cutting to length on a horizontal band or power hacksaw
L - 37	Chucking in a collet chuck
D - 1	Drilling on a drill press
L - 14	Turning a shoulder on a lathe
M - 42	Using a surface plate
M - 40	Measuring with a sine bar
D - 8	Center drilling on a drill press
S - 5	Cutting a circle on a vertical bandsaw
SP - 1	Truing a vice in a shaper
SP - 2	Shaping a horizontal surface
SP - 3	Shaping an angle using a vice
D - 5	Counterboring on a drill press


1/4 DRILL
3/8 DRILL
4
3/4
3/8
1-3/4
1-7/8
1-1/4
3
3/4
5/16
1/4
NO. 1 JAW
1/4
3/4
1-1/4
3/8
1-3/4
1-7/8
3
3/4
4
CBORE 3/8 DIA. 1/8 DEEP WITH 3/8-16 NC
3/8-16 NC
NO. 2 JAW
5/8 DIA.
3/8 - 16 NC
NO. 1 SCREW
2
KNUR
1/8 DRILL
4 -1/8
3/4
4 -7/8
5/8 DIA
3/8-16 NC
NO. 2 SCREW
2
KNURL
1/4
1/8 DRILL
3/8
3-1/4
3/4
4-3/8
ASSEMBLY NOT TO SCALE

13

NO.	REQ	NAME AND OR SIZE	MAT
3	2	3/4 X 3/4 X 4-1/4	CRS
2	2	5/8 DIA. X 6-1/2 ROUND	CRS
1	2	1/8 DIA. X 2 ROLL PINS	CRS

BRUNING 40-105

SCALE FULL		REVISIONS	BY	DATE
DATE				
DR'N GWB	CKD			
AP'VD				

TITLE

PARALLEL CLAMPS

NO 81

PARALLEL CLAMPS

PROJECT #81

PROCEDURES: Screw #1

1. Check the 5/8" diameter stock size
2. Cut to 6½" long
3. Chuck in a lathe
    a. Chuck in a three-jaw chuck
    b. Have 1" extending from the chuck
4. Face
5. Center drill
    a. Use a #2
6. Pull the stock out and support with the tailstock
    a. Chuck on 1"
7. Turn the 3/8" diameter
8. Thread
    a. Check with a thread micrometer
9. Knurl the head
10. Cut to length
    a. Use a horizontal band saw
11. Chuck on the threads
    a. Use a collet chuck
12. Face to length
13. Chamfer
14. Drill the 1/8" hole
    a. Use a drill press

Screw #2

15. Follow procedures # 1-8 for screw #1

16. Turn the ¼" shoulder 3/8" long

17. Follow procedures # 9-14 for screw #1

Jaw #1

18. Cut to 4¼" long

19. Layout the holes

    a. Allow 1/16" for saw cut

20. Layout the angles

    a. Use a surface plate

    b. Use a sign bar

21. Center drill the end hole

    a. Use a #4 center drill on a drill press

22. Mount on a vertical band saw

23. Cut the circular end

    a. Use a circle cutter

    b. Dress if necessary with a belt sander or file

24. Drill the holes

25. Mount in a shaper vice

    a. True the vice

26. Cut the length

    a. Use a square

27. Set-up and cut the angle

    a. Use a surface gage

28. De-bur all edges

Jaw #2

29. Follow procedures #18-24 for Jaw #1

30. Tap the holes

31. Counterbore the hole in the end

32. Follow procedures #25-28 for Jaw #1

Assembly

33. Press the roll pins in the screw holes

34. Fasten the jaws together with the screws

MACHINE SHOP

PROJECT #82

1-2-3 BLOCKS I

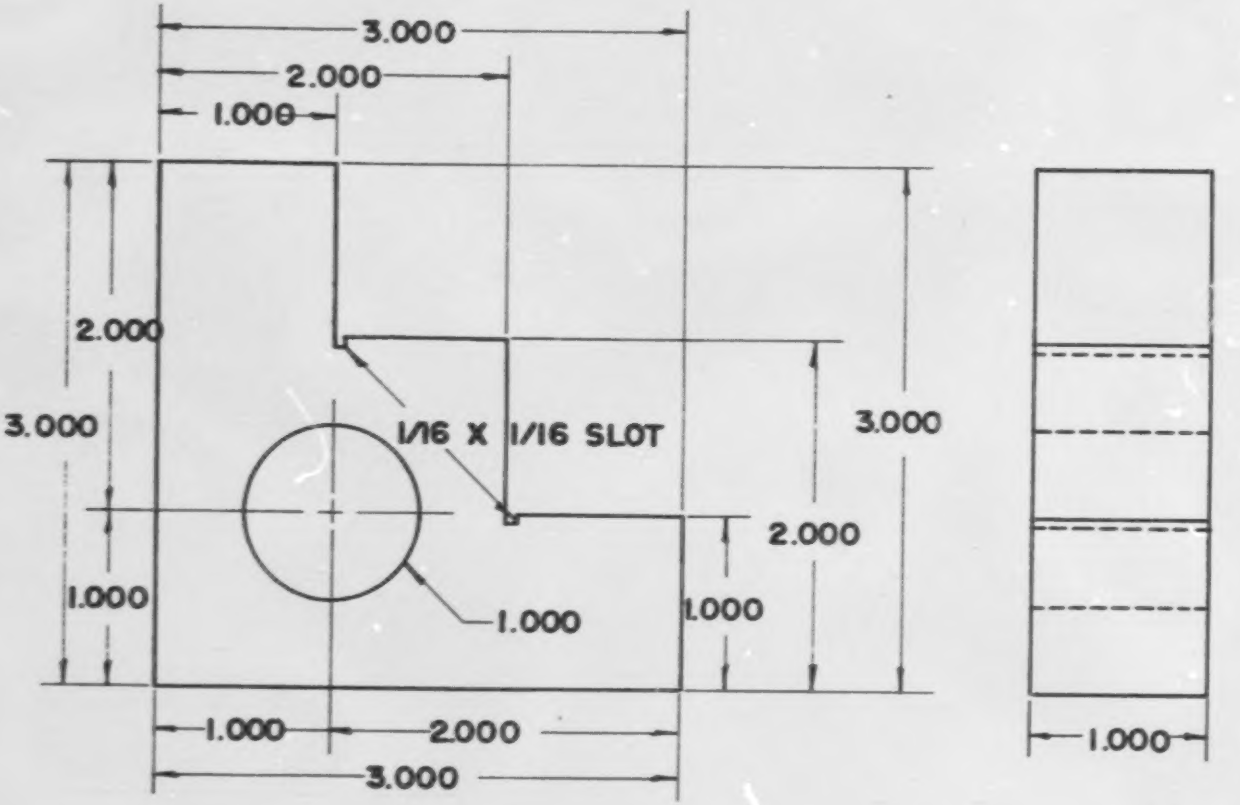
1-2-3 BLOCKS I

PROJECT #82

COURSES: Measuring, Drill Presses, Shaper

MATERIALS: Two Each - Cold Rolled Steel Flat 1" x 3" x 3¼" long

TASK:	SP - 1	Truing a vice in a shaper
	M - 42	Using a surface plate
	M - 35	Measuring with a vernier height gage
	SP - 2	Shaping a horizontal surface
	SP - 6	Shaping a vertical surface
	SP - 5	Grinding a shaper tool
	SP - 7	Shaping a slot
	D - 1	Drilling on a drill press
	D - 2	Reaming on a drill press
	D - 3	Boring on a drill press


3.000
2.000
1.000
2.000
3.000
1.000
1/16 X 1/16 SLOT
3.000
2.000
1.000
1.000
1.000
2.000
3.000
1.000

MATERIAL: CRS FLAT 1 X 3 X 3-1/4 (2 REQUIRED)

TOLERANCES: +- 1/64 · +- .002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB | CKD			
AP'VD.			

TITLE 1-2-3 BLOCKS I

NO. 650 82

649

1-2-3 BLOCKS I

PROJECT #82

SPECIAL INSTRUCTIONS: Project may be case hardened and ground. If so, allow .010" for grinding. To conserve time the project may be rough cut on a band saw.

PROCEDURES:

1. Check the stock size
2. Cut to 3¼" long
3. True a vice on a shaper
4. Layout the steps
   a. Use a surface plate
   b. Use a vernier height gage
5. Cut the saw cut side square in the shaper vice
6. Reverse ends
   a. Shape to length
      (1) Use the micrometer collar
      (2) Check with a micrometer dept gage
7. Rough out the steps
8. Finish the steps
   a. Zero the table and the head micrometer collars
      (1) Use a vertical cut and a horizontal cut
9. Grind an off-set necking tool
10. Neck the slots
11. Place in a drill press
12. Drill and ream the hole
    a. Boring the hole will provide boring skills on a drill press
13. De-bur

MACHINE SHOP

PROJECT #83

V-BLOCKS

V-BLOCKS

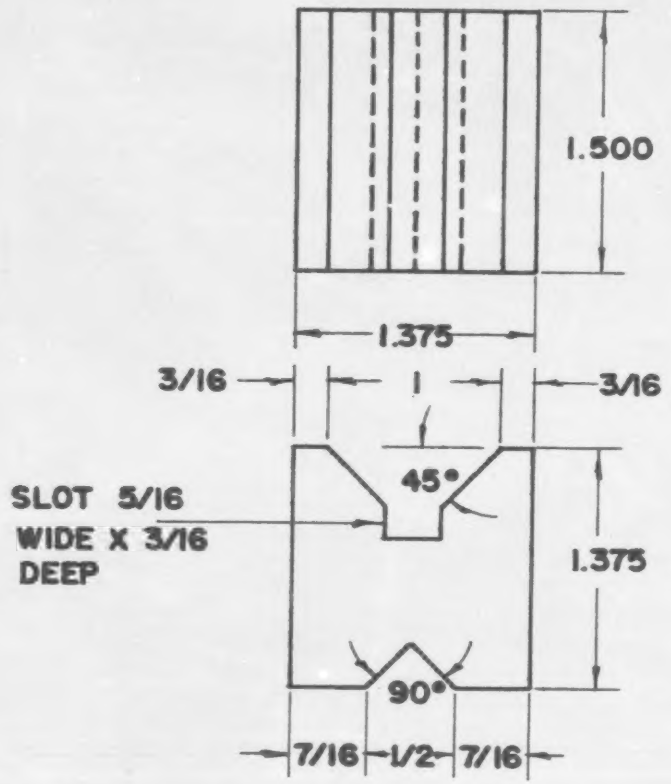
PROJECT #83

COURSES: Measuring, Shaper, Milling Machines, Grinding

MATERIALS: One Each - Hot Rolled Steel Square 1½" x 1½" x 3½" long

TASK:

SP - 1	Truing a vice in a shaper
SP - 2	Shaping a horizontal surface
SP - 6	Shaping a vertical surface
SP - 5	Grinding a shaper tool
SP - 8	Form cutting on the shaper
ML - 1	Aligning a vise on a milling machine
ML - 7	Angle milling on a vertical milling machine
ML - 5	End milling
ML - 2	Slot milling on a vertical milling machine
G - 4	Grinding a flat on a surface grinder
G - 13	Grinding on a magnetic chuck
G - 1	Dressing the wheel
G - 5	Grinding an angle on a surface grinder
G - 10	Grinding a finishing cut
G - 7	Form grinding on a surface grinder
G - 15	Using a cut-off wheel
M - 33	Measuring with a micrometer depth gage
M - 42	Using a surface plate
M - 41	Using a dial indicator
M - 35	Measuring with a vernier height gage



1.500
1.375
3/16
1
3/16
45°
SLOT 5/16
WIDE X 3/16
DEEP
1.375
90°
7/16
1/2
7/16

MATERIAL: 2 EA. HRS SQUARE 1-1/2 X 1-1/2 X 3-1/2 TOLERANCES: +- 1/64 · +- .002 +- 1°

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD.			
AP'VD.			
TITLE V- BLOCKS	NO. 655		

654

V-BLOCKS

PROJECT #83

SPECIAL INSTRUCTIONS: Part of this project may require advanced skills. Both V-blocks should be made together and cut after machining.

PROCEDURES:

1. Check the stock size
2. Cut the stock 3½" long
3. True a shaper vise
4. Square the stock to size
    a. Use the round rod method
        (1) Place a 3/4" diameter cold rolled steel bar parallel to the movable jaw, center on the block
5. Shape the saw cut ends square
    a. Make a vertical cut
6. Layout the angles to be cut
7. Form grind a tool
8. Set-up the stock in the shaper vise
9. Form cut the small angle
10. Remove the stock from the shaper
11. True a vise on a vertical mill
12. Swing the head 45°
13. Mount the stock in the vise
14. Mount a 3/4" end mill
15. Center the edge of the cutter on the center of the stock
16. Raise the table and zero the micrometer collar
17. Cut the large angle by raising the table
    a. Full depth should be .500"

18. Straighten the head

19. Mill the 5/16" slot

    a. Use an end mill

20. De-bur

21. Case harden

22. Grind square on a surface grinder

    a. Grind on a magnetic chuck

23. True an angle vise on a surface grinder

24. Swing the vice 45°

    a. This will make the 45° surfaces at right angles to the grinder

25. Dress the wheel square

26. Grind the angles parallel to the bottom

    a. Be sure the V-block is seated on parallels

    b. Grind the angle vertically (down)

        (1) Grind enough to clean up the surface - finish grind

    c. Grind the angle horizontally

        (1) Only enough to clean up the surface - finish grind

27. Cut the small angle by form grinding

    a. Dress the wheel

    b. Use a magnetic chuck

        (1) True the work

    c. Form grind the angle

28. Cut in half with a cut-off wheel

29. Grind to length

    a. Check with a micrometer depth gage

30. To check accuracy of the V-blocks

    a. Place the V-blocks on a surface plate

    b. Mount a dial test indicator on a vernier height gage

c. Place a test bar in the V-blocks

    (1) Have the blocks at least 6" apart

d. Zero the dial indicator on one end of the test bar

    (1) Be sure the indicator is zeroed at the exact top of the test bar

e. Move the height gage to the opposite end of the test bar and read the indicator

31. Check the angles with a sine bar

MACHINE SHOP

PROJECT #84

TWO INCH STEP BLOCKS

659

TWO INCH STEP BLOCKS

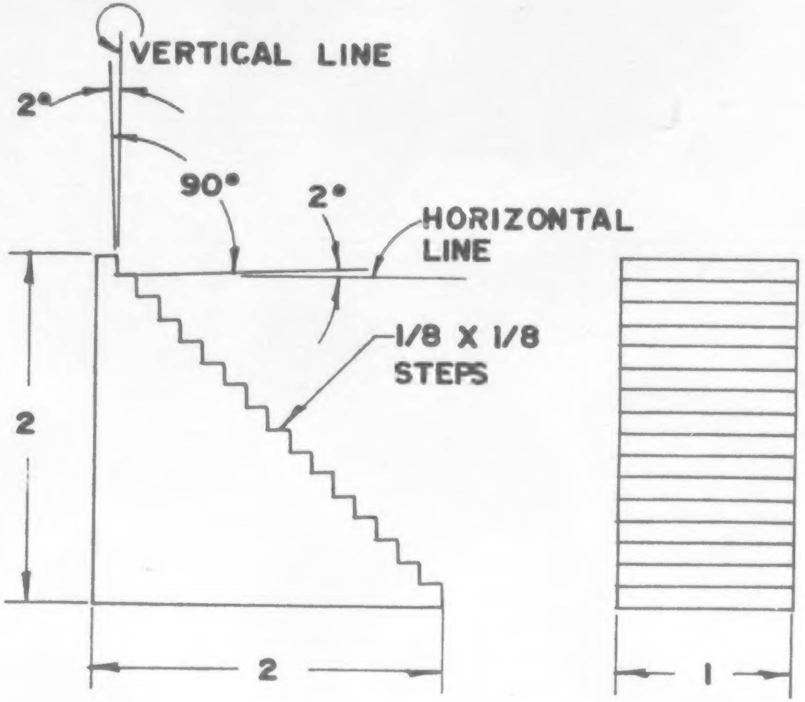
PROJECT #84

COURSES: Shaper

MATERIALS: Two Each - Cold Rolled Steel Flat 2" x 1" x 2 1/8" long

TASK:

SP - 2	Shaping a horizontal surface
SP - 1	Truing a vise in a shaper
SP - 3	Shaping an angle using a vise
SP - 5	Grinding a shaper tool
SP - 8	Form cutting on the shaper


VERTICAL LINE
2°
90°
2°
HORIZONTAL LINE
1/8 X 1/8 STEPS
2
2
1

MATERIAL: CRS FLAT 2 X 1 X 2-1/8 (2 REQUIRED) TOLERANCES: +- 1/64 · +- 1/2°

SCALE FULL
REVISIONS
BY
DATE
DATE
DR'N GWB
CKD.
AP'VD

TITLE
TWO INCH STEP BLOCKS

NO.
662 84

661

TWO INCH STEP BLOCKS

PROJECT #84

SPECIAL INSTRUCTIONS: This project may be roughed out on a vertical band saw to conserve time.

PROCEDURES:

1. Check the stock size
2. Cut to 2 1/8" long
3. Shape the sides square
   - a. True a shaper vice
4. Layout the angle
   - a. 1/8" from the corners
5. Place the scribed line parallel to the jaws of the vise
   - a. ⅛" above the vise jaws
     - (1) Use a surface gage
6. Shape to the line
7. Grind a form grinding tool
   - a. 90° included angle 45° from the side
8. Set the tool shank 2° off 90°
   - a. Use a protractor
9. Line the tool point on the edge of the scribe line
   - a. Zero the head and table micrometer collar
10. Advance the table .088"
11. Start the cut
    - a. Feed the head down .088"
12. Move the table .177"
13. Cut the second tooth .088" deep
14. Continue until all teeth have been cut
15. De-bur

REFERENCES

1. Krar, S. F. and Oswald, J. W.: Grinding Technology. Albany: Delmar Publishers, 1974.

2. Lascoe, Nelson, Porter; Machine Shop - Operations and Setups. Chicago: American Technical Society, 1973

3. Oberg, Erik and Jones, F. D.: Machinery's Handbook. New York, N.Y.: Industrial Press Inc., 1976

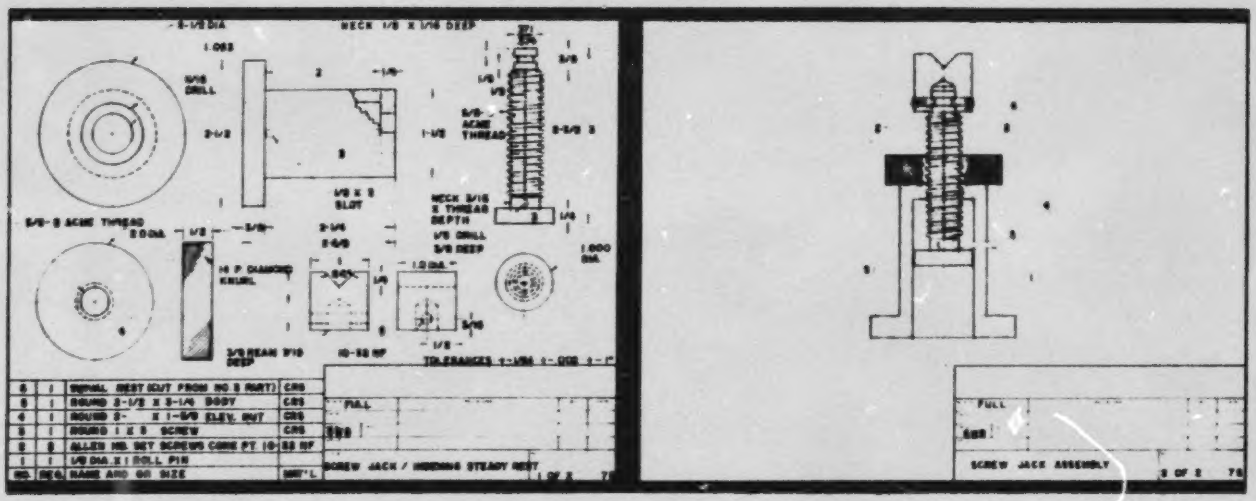
4. Morse: Machinist's Practical Guide. New Bedford, Mass: Morse Cutting Tools Division, 1978

5. Krar, S.F.; Oswald, J. W. and St. Amond, J. E.: Technology of Machine Tools. New York: McGraw-Hill Book Company, Gregg Division, 1977

MACHINE SHOP PROJECTS

MILLING, GRINDER
Projects 85-99

GRINDING
Projects 100-101



NECK 1/8 X 1/16 DEEP
5/8-8 ACME THREAD
1/8 X 3 SLOT
TOLERANCES
FULL
SCREW JACK / GRINDING STEADY REST
1 OF 2
SCREW JACK ASSEMBLY
2 OF 2

STUDENT MANUAL

Georgia Department of Education

PURPOSE

A student in Machine Shop must learn by doing. Although lectures, reading assignments, and audio-visual aids are very necessary, these methods alone will never produce a good machinist. The combination of both classroom and shop practice is essential to your training. The purpose of this Shop Project Guide is to give the necessary shop experience to complement your classroom training. This guide is based on the author's years of practical experience as a skilled machinist and as a teacher in the field. Each skill needed to complete a phase of your training has been identified. Next, projects have been devised to give hands-on experience for each skill with enough repetition so that you will become capable of using each tool or attachment for the particular machine or operation being taught. Your instructor will help you select or will assign the projects in the necessary order. You will also find the end products of these projects will be useful tools that will help in your training that follows. This serves not only to make the projects more interesting, but more enjoyable to construct. This practical training along with classroom instruction and applied learning can bring you a rewarding future as a skilled tradesman.

PROJECT LISTING (CATEGORIZED)

MEASURING, LAYOUT, BENCH WORK

1. Center gage
2. Drill point gage
3. Anchor bolt
4. Mallet
5. Stud block
6. Studs
7. Test Block I
8. T-slot cleaner
9. Dial indicator stand

MEASURING, LAYOUT, BENCH WORK, SAWS

10. Tap wrench
*11. Pipe flange assembly
*12. C-clamp
*13. Block and tackle
*14. Steel beam trammels

MEASURING, LAYOUT, SAWS, DRILL PRESSES

15. Display projects
*16. Jack Stand
*17. Gear puller
18. Tool post base

667

MEASURING, LAYOUT, GRINDER, LATHE

19. Right hand tool (genreal purpose)
20. Left hand tool (general purpose)
21. Left hand tool (roughing)
22. Right hand tool (roughing)
23. Left hand tool (turning or finishing)
24. Right hand tool (turning or finishing)
25. Necking tool
26. Left hand tool (facing)
27. Right hand tool (facing)
28. V-threading tool
29. V-threading tool (off-set)
30. Acme threading tool

LATHE

31. Micrometer test block
32. Flaring tool
33. 1/4" pin punch
34. 3/16" pin punch
35. 1/8" pin punch
36. Center punch
37. Prick punch
38. Nail set
39. Scriber
40. Dead center
41. Plumb bob

42. Dumbbell set

43. Taper plug gage

44. Rocker dish

45. Rocker

46. Tool post body

47. Circle cutter

48. Saw jig (fly cutter)

LATHE, MILLING MACHINES

*49. Tap wrench II

*50. Fly cutter

51. Tooth pick holder

*52. Pipe center

53. Taper ring gage

54. Set up bolt 1/2" x 4"

55. Set up bolt 1/2" x 6"

56. Set up bolt 1/2" x 8"

57. Set up bolt 3/8" x 4"

58. Set up bolt 3/8" x 6"

59. Drill reducer

60. Tap drill extension (1/4" - 20 NC tap drill)

61. Tap drill extension (5/16" - 18 NC tap drill)

62. Boring bar holder body jig

63. Boring bar holder body

*64. Boring bar holder base

65. Boring bar holder inner body

66. Boring bar holder base jig

669

67. Precision measuring tool block

*68. Milling arbor #40 - 3/8"

*69. Milling arbor #40 - 1/5"

*70. Milling arbor #40 - 5/8"

*71. Milling arbor #40 - 3/4"

*72. Lathe arbor

73. Mallet

74. Acme thread/boring tool

*75. Screw jack/indexing steady rest

76. Lathe chuck wrench

77. Internal pipe wrench

78. Buffer/grinder shaft

SHAPER

79. Splitting wedge

80. Flat strap clamp

*81. Parallel clamp

SHAPER, GRINDER

82. 1-2-3 blocks I

*83. V-blocks

84. Two inch step blocks

MILLING, GRINDER

85. Beveled straight edge

86. Solid key seat

87. Water valve wrench

88. Paper hone

*89. Boring bar set

90. U-clamp

91. Goose neck clamp

92. Three inch T-slot bolt

93. 1-2-3 blocks II

94. Three inch step blocks

95. T-slot nut

*96. Die stock

97. Geared ash tray

*98. Wrench

99. 1/4" pitch, 1' lead, Left Hand, square thread bolt

GRINDING

100. Parallels

101. Grinder test bar

MACHINE SHOP

PROJECT #85

BEVELED STRAIGHT EDGE

672

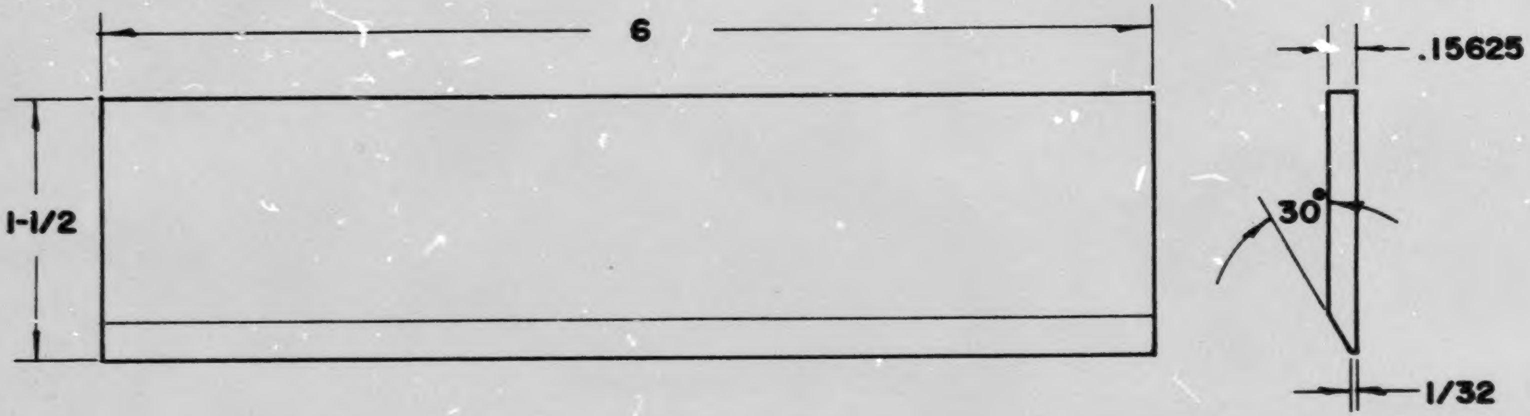
BEVELED STRAIGHT EDGE

PROJECT #85

COURSES: Milling Machines, Grinder

MATERIALS: One Each - Oil Hardening Non-Deforming flat 1½" x 3/16" x 6¼" long

TASK:	ML - 1	Aligning a vise on a milling machine
	ML - 4	Plain milling/slab milling
	ML - 8	Angle milling on a horizontal milling machine
	G - 1	Dressing the wheel for grinding
	G - 4	Grinding a flat on a surface grinder
	G - 13	Grinding on a magnetic chuck
	G - 5	Grinding an angle on a surface grinder



MATERIAL: STEEL OIL HARDNING NON DEFORMING
FLAT 1-1/2 X 3/16 X 6-1/4 (1 REQUIRED)

TOLERANCES: +- 1/64 · +- .002 · +- 1°

674

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DR'N GWB	CKD			
AP'VD.				

TITLE
BEVELED STRAIGHT EDGE

NO. 675

85

BEVELED STRAIGHT EDGE

PROJECT #85

SPECIAL INSTRUCTIONS: Part of this project may require advanced machining methods.

PROCEDURES:

1. Check the stock size
2. Cut to 6¼" long
3. True a vise on a horizontal milling machine
4. Mill the ends square and to length
    a. Use a plain side milling cutter
5. Mill the angle
    a. Use an angle cutter
6. Heat treat
7. Grind the flats on a surface grinder
    a. Dress the wheel
    b. Use a magnetic chuck
8. Grind the angle
    a. True an angle vise on a surface grinder
9. Zero the vise
10. Grind the 1/32" flat

MACHINE SHOP

PROJECT #86

SOLID KEYSEAT RULE

SOLID KEYSEAT RULE

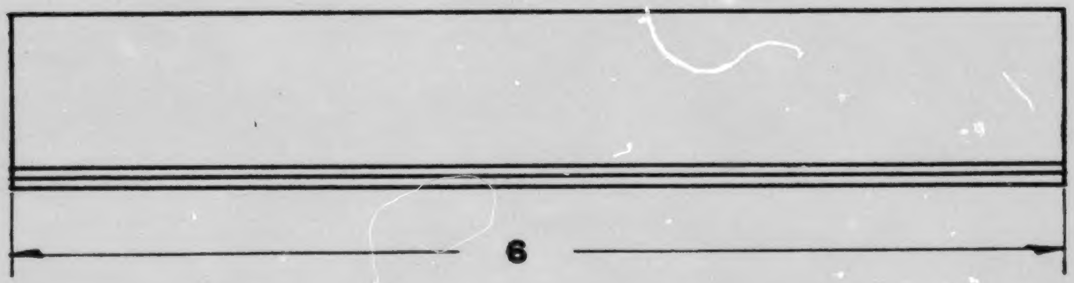
PROJECT #86

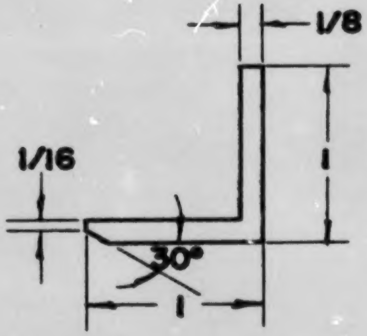
COURSES: Measuring, Milling

MATERIALS: One Each - Cold Rolled Steel Square 3/4" x 3/4" x 8" long

TASK:

M - 41	Using a dial indicator
ML - 5	End milling
ML - 7	Angle milling on a vertical milling machine
M - 30	Measuring with an outside micrometer caliper
ML - 1	Aligning a vise on a milling machine





MATERIAL: 1 EA. CRS SQUARE 1 X 1 X 8

TOLERANCES: +-1/64 · +-1°

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DATE			
DR'N GWB CKD.			
AP'VD.			

TITLE
SOLID KEY SEAT

NO.
680

679

86

SOLID KEYSEAT RULE

PROJECT #86

SPECIAL INSTRUCTIONS: Steel must be normalized before machining to prevent warping.

PROCEDURES:

1. Check the stock size
2. Cut to 8" long
3. Mount on a vertical milling table
    a. Use strap clamps
        (1) Place one clamp ½" from each end
    b. Indicate true
4. Rough out the angle
    a. Use an end mill
5. Finish mill the angles
    a. Check with an outside micrometer
6. Place in the saw
7. Cut the ends
    a. Leave at least 6½" of angle
8. True a vise on a vertical mill
9. Mount the stock in the vise
    a. Clamp on one angle
10. Face to length
11. Tilt the head 30°
12. Cut the angle
13. De-bur all edges

681

MACHINE SHOP

PROJECT #87

WATER VALVE WRENCH

682

WATER VALVE WRENCH

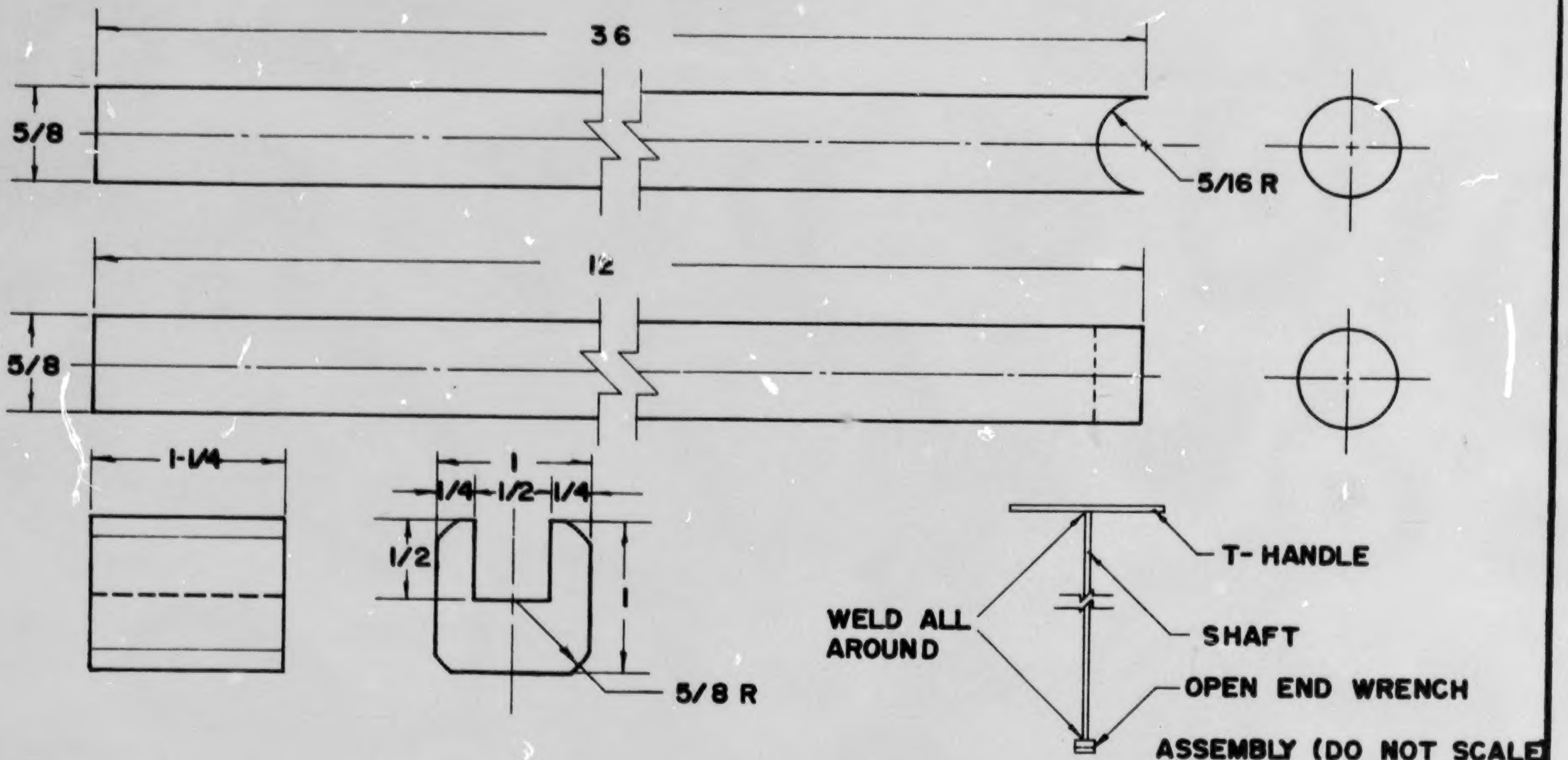
PROJECT #87

COURSES: Lathe, Milling Machines

MATERIALS:
One Each - Hot Rolled Steel Round 5/8" diameter x 12¼" long
One Each - Hot Rolled Steel Round 5/8" diameter x 36¼" long
One Each - Hot Rolled Steel Round 1¼" diameter x 1½" long

TASK:

ML - 1	Aligning a vise on a milling machine
ML - 6	Fly Cutter/shell end mill (Face milling)
ML - 3	Slot milling on a horizontal milling machine
ML - 5	End milling
ML - 11	Form milling
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 17	Filing in a lathe


36
5/8
5/16 R
12
5/8
1-1/4
1
1/4
1/2
1/4
1/2
1
5/8 R
T- HANDLE
WELD ALL AROUND
SHAFT
OPEN END WRENCH

ASSEMBLY (DO NOT SCALE)

MATERIALS:

1 EA. HRS ROUND 5/8 DIA. X 12-1/4
1 EA. HRS ROUND 5/8 DIA. X 36-1/4
1 EA. HRS ROUND 1-1/4 DIA. X 1-1/2

684

TOLERANCES: +- 1/32 · +- .003

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB · CKD.			
AP'VD.			

TITLE
WATER VALVE WRENCH

NO. 685

87

WATER VALVE WRENCH

PROJECT #87

PROCEDURES: Open End

1. Check the 1¼" diameter stock for size
2. Cut to 1½" long
3. True a vise on a vertical milling machine
4. Place the stock on parallels in the vise
    a. Tighten the vise
    b. With a mallet drive the work down
        (1) Check to see the parallels are tight
        (2) Do not re-tighten the vise
5. Mill the first side
    a. Use a fly cutter or shell end mill
6. Place the pre-milled side on the solid jaw of the vise
    a. Tap stock down on parallels
7. Cut all four sides
8. With the fourth side up insert an end mill
    a. Mill the slot
9. Stand on end and mill both ends
    a. Mill to length
10. De-bur

Shaft

11. Insert the shaft in a vise
    a. Lay on parallels
    b. Have 1" extending from the vise

686

(1) On the side where the radius is to be cut

12. Insert a 5/8" end mill

13. Form cut the radius

14. Place in a lathe

    a. Use a three-jaw chuck

15. Face the end

    a. Opposite from the radius

16. Chamfer

    a. Use a file

T-Handle

17. Chuck in a lathe

    a. Use a three-jaw chuck

18. Face both ends to length

19. Chamfer

    a. Swing the cutting edge approximately 45° to cut

Assembly

20. Center the T-handle in the radius of the body

21. Square and weld all around

22. Center and square the T-handle assembly on the back of the open end

    a. Opposite side from the slot

    b. T-handle parallel to the slot

23. Weld all around

24. De-bur

25. Paint (optional)

MACHINE SHOP

PROJECT #88

PAPER HONE

688

PAPER HONE

PROJECT #88

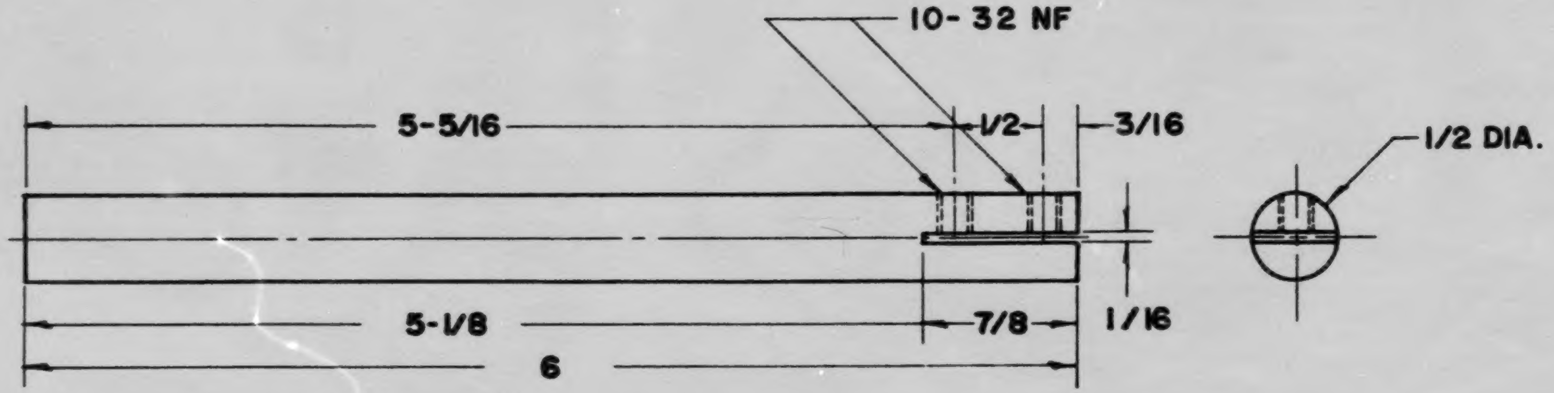
COURSES: Drill Presses, Lathe, Milling Machines

MATERIALS: One Each - Cold Rolled Steel Round ½" diameter x 6¼" long

Two Each - Allen Head Set Screws 10-32 NF x 3/16" long

TASK:

L - 6	Chucking in a three-jaw chcuk
L - 8	Facing in a lathe
L - 17	Filing in a lathe
ML - 14	Indexing on a milling machine
ML - 13	Slitting and parting
ML - 3	Slot milling on a horizontal milling machine
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press


10- 32 NF
5-5/16
1/2
3/16
1/2 DIA.
5-1/8
7/8
1/16
6

MATERIALS: 1 EA. CRS ROUND 1/2 DIA. X 6-1/4
2 EA. ALLEN HD. SET SCREWS 10-32 X
3/16 LONG

TOLERANCES: +-1/64

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AP'VD.			

TITLE
PAPER HONE

690

691

BRUNING 40-105

PAPER HONE

PROJECT #88

SPECIAL INSTRUCTIONS: This project may be used in the tailstock chuck on a lathe. By inserting emery paper in the slot and wrapping it to the hole size to be honed small amounts of metal may be removed. CAUTION: Rap the paper in the same direction as the rotation of the chuck.

PROCEDURES:

1. Check the stock size
2. Cut the stock 6¼" long
3. Mount in a lathe
    a. Use a collet chuck
4. Face to length
5. Chamfer the ends
    a. Use a file
6. Mount a dividing head on a horizontal mill
    a. Swing the head of the dividing head vertically
7. Insert the stock
    a. Have 1" extending from the chuck jaws
8. Place a slitting saw on the arbor
    a. 1/16" wide
9. Center the cutter over the stock
10. Cut the slot
11. Remove from the mill
12. Drill and tap the holes
    a. Use a drill press

MACHINE SHOP

PROJECT #89

BORING BAR SET
(¼" - 3/4" - 1 1/8")

693

BORING BAR SET
(¼" - 3/4" - 1 1/8")

PROJECT #89

COURSES: Drill Presses, Lathe, Milling Machines Saws

MATERIALS:

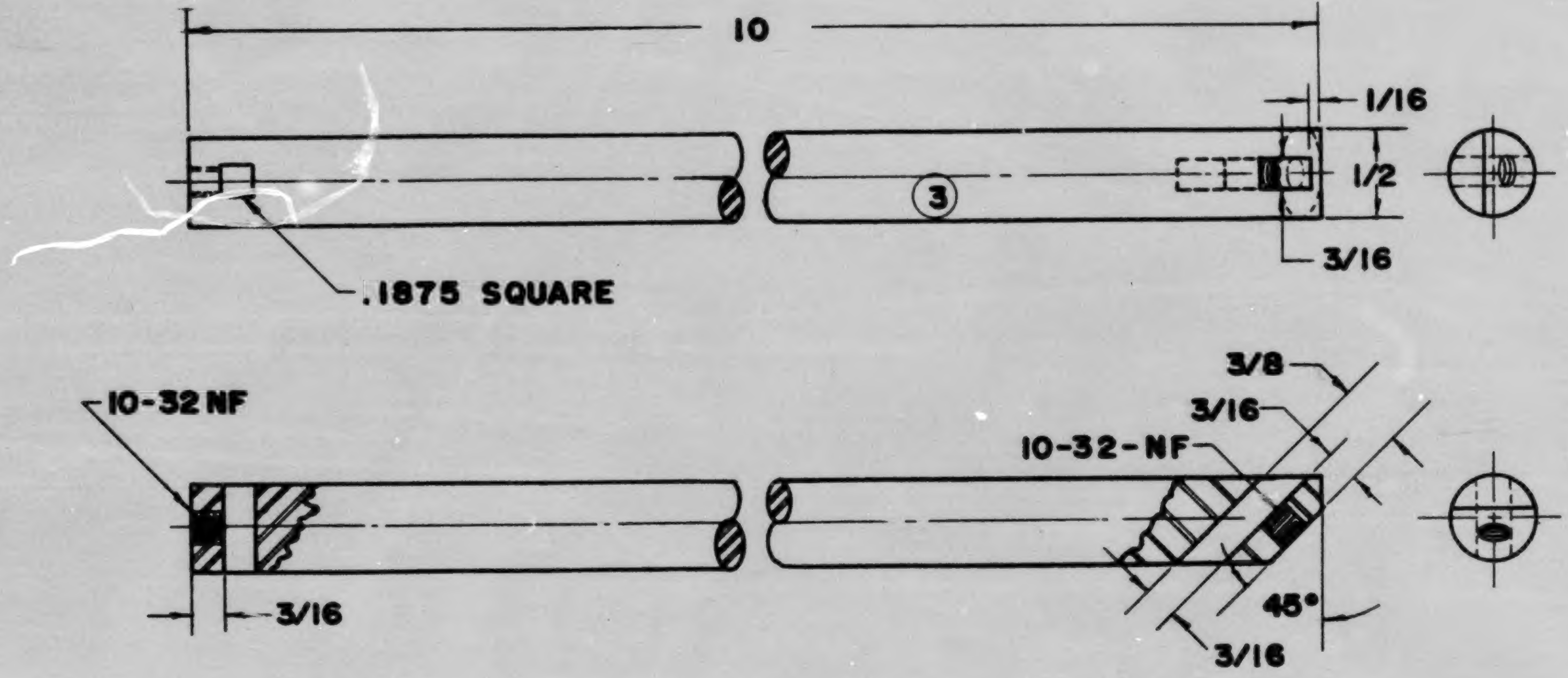
One Each - Cold Rolled Steel Round ½" diameter x 10½" long
One Each - Cold Rolled Steel Round 3/4" diameter x 12½" long
One Each - Cold Rolled Steel Round 1 1/8" diameter x 14½" long
Four Each - Allen Head Set Screws 10-32 NF x 3/16" long
Two Each - Allen Head Set Screws ¼-20 NC x ¼" long
One Each - Cold Rolled Steel Square 3/16" x 3/16" x 1½" long
One Each - Cold Rolled Steel Square ¼" x ¼" x 2½" long
One Each - Cold Rolled Steel Square 3/8" x 3/8" x 4" long

TASK:

S - 1	Cutting to length on a horizontal band or power hacksaw
S - 2	Cutting an angle on a horizontal band saw
ML - 14	Indexing on a milling machine
ML - 7	Angle milling on a vertical milling machine
ML - 6	Fly cutter/shell end mill (face milling)
ML - 5	End Milling
ML - 2	Slot milling on a vertical milling machine
L - 8	Facing in a lathe
L - 37	Chucking in a collet chuck
L - 9	Turning in a lathe
L - 18	Polishing in a lathe
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe

694

L - 24	Tapping in a lathe
D - 8	Center drilling on a drill press
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press


10
1/16
1/2
3/16
.1875 SQUARE
3
10-32 NF
3/16
3/8
3/16
10-32-NF
45°
3/16

TOLERANCES: +-1/32· +-.003

SCALE FULL

DATE

DR'N GWB

CKD.

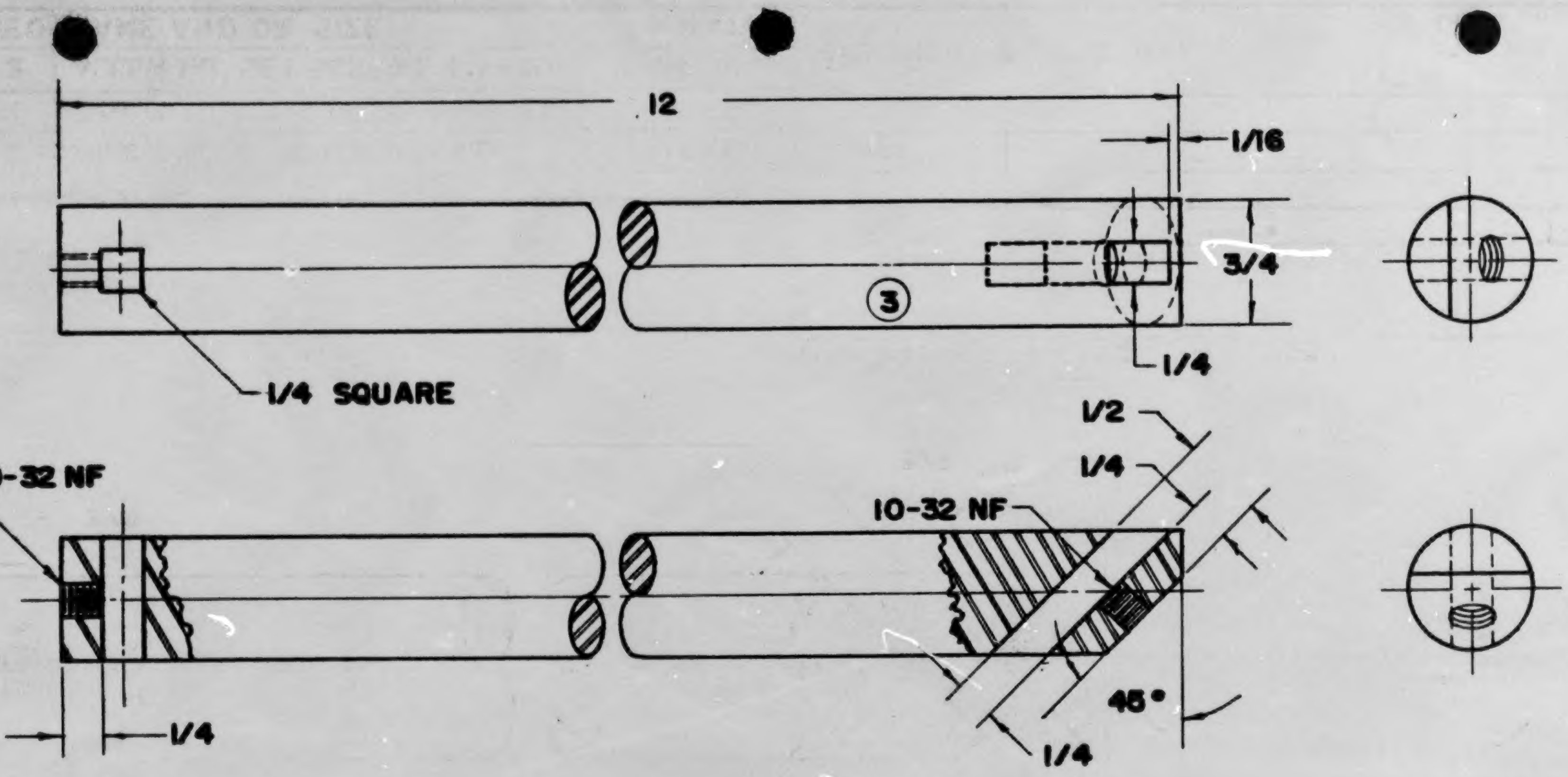
AP'VD.

REVISIONS	BY	DATE

TITLE 1/2 INCH BORING BAR

NO. 1 [illegible] 3 89

3	1	1/2 DIA. X 10-1/2 ROUND	CRS
2	1	3/16 X 3/16 X 1-1/2 (NOT SHOWN)	CRS
1	2	ALLEN HD. SET SCREWS 10-32 NF X	3/16
NO.	RE[illegible]	NAME AND OR SIZE	MA[illegible]


12
1/16
3/4
1/4
③
1/4 SQUARE
1/2
1/4
10-32 NF
10-32 NF
1/4
45°
1/4

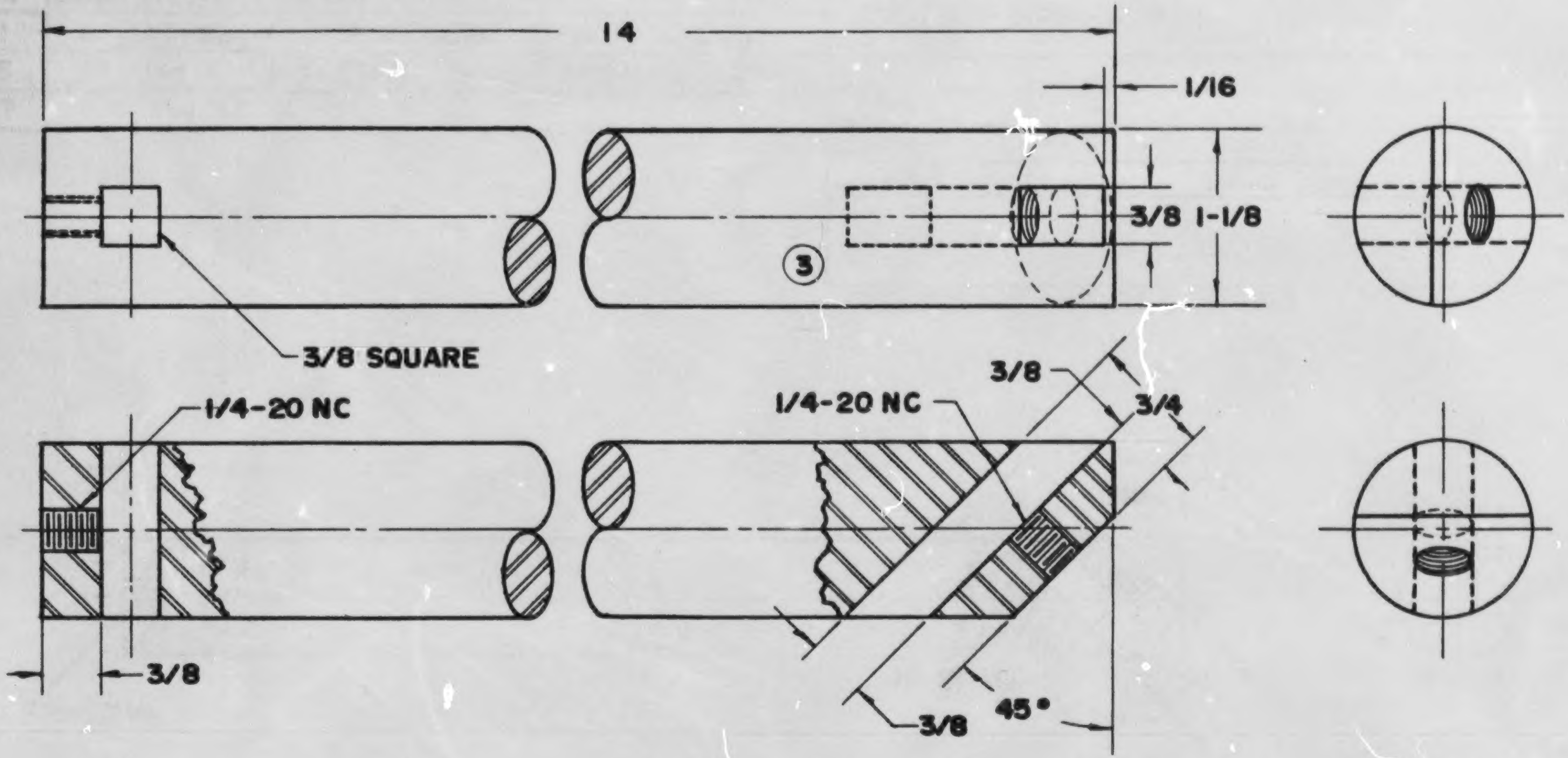
TOLERANCES: +-1/32· +-.003

NO.	REQ	NAME AND OR SIZE	MAT.
3	1	3/4 DIA. X 12-1/2 ROUND	CRS
2	1	1/4 X 1/4 X 2-1/2 (NOT SHOWN)	CRS
1	2	ALLEN HD. SET SCREWS 10-32NF X 3/16	

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB	CKD.		
AP'VD.			

TITLE
3/4 INCH BORING BAR

NO.
2 OF 3 89


14
1/16
3/8
1-1/8
③
3/8 SQUARE
1/4-20 NC
1/4-20 NC
3/8
3/4
3/8
3/8
45°

TOLERANCES: +- 1/32 · +- .003

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB	CKD.		
AP'VD.			
TITLE 1-1/8 INCH BORING BAR	NO. 3 OF 6 89		

NO.	REQ.	NAME AND OR SIZE	MAT.
3	1	1-1/8 DIA. X 14-1/2 ROUND	CRS
2	1	3/8 X 3/8 X 4 (NOT SHOWN)	CRS
1	2	ALLEN HD. SET SCREWS 1/4-20NC X 1/4	

BRUNING 40-105

BORING BAR SET

(½" - 3/4" - 1 1/8")

PROJECT #89

SPECIAL INSTRUCTIONS: The procedures are the same on all bars. Follow these procedures and complete the set. Chatter may result on the larger bars if a small dividing head is used. If so, mount in a vise or clamp to the side of the milling table, swing and extend the ram.

PROCEDURES:

1. Check the stock size
2. Cut to length
    a. Allow ½" for facing
    b. Use a horizontal band saw
3. Cut a 45° angle
    a. Use a horizontal band saw
4. Mount in a dividing head in a vertical mill
    a. Swing the dividing head 45°
    b. Level the pre-cut surface with a level
5. Mill the angle
    a. Use a fly cutter or a shell end mill
6. Mount an end mill in the spindle
    a. Center the end mill over the surface
7. Cut the slot
8. Remove from the mill
9. Cut the square stock
10. Mount in the top of the slot
    a. Groove for welding
    b. To insure proper spacing, mount a piece of keystock where the hole will be. Add .004 shim for clearance

11. Weld the outer stock on the end

    a. Remove the spacer and shim

12. Re-mount in the mill and mill the weld

13. Mount in a lathe and face to 1/16" from the hole

    a. Use a collet chuck

14. Machine the outer surface smooth

15. Polish

    a. Use emery paper

16. Reverse ends and face to length

17. Place in the mill and cut the slot

    a. Have the dividing head spindle vertical

18. Repeat procedure 9 - 11

19. Re-mount in a lathe

20. Turn the outside smooth

21. Face the weld

22. Chamfer

23. Polish

24. Center drill

25. Drill and tap the hole in the lathe

26. Remove from the lathe

27. Mount in a drill press and level the angle

28. Center drill

29. Drill and tap the hole in the angle end

    a. The hole is not centered on the outside of the angle surface, but in the center of the slot

30. Repeat procedure 1 - 29 for all bars in the set or make all three at once to save time

MACHINE SHOP

PROJECT #90

U-CLAMP

704

U-CLAMP

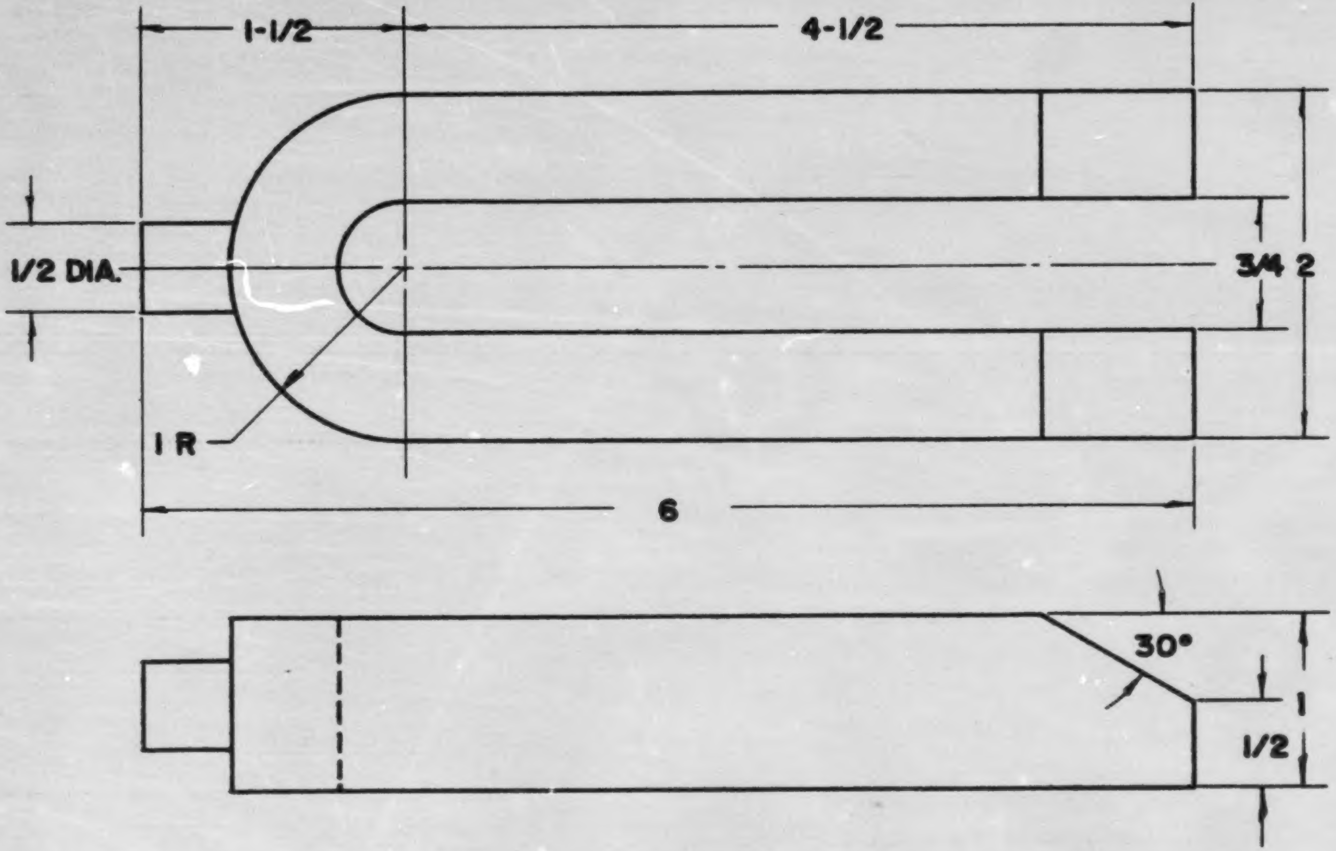
PROJECT #90

COURSES: Lathe, Milling Machines

MATERIALS: One Each - Cold Rolled Steel Round 1" x 2" x 6¼" long

TASK:

ML - 17	Using a rotary table on a milling machine
ML - 5	End milling
ML - 2	Slot milling on a vertical milling machine
ML - 7	Angle milling on a vertical milling machine
L - 7	Chucking in a four-jaw chuck
L - 8	Facing in a lathe


1-1/2
4-1/2
1/2 DIA.
3/4
2
1 R
6
30°
1
1/2

MATERIAL: 1 EA. CRS FLAT 1 X 2 X 6-1/4

TOLERANCE: +- 1/64

706

SCALE FULL		REVISIONS	BY	DATE
DATE				
DR'N GWB	CKD			
AP'VD.				
TITLE U- CLAMP		NO. 70		90

BRUNING 40-105

U-CLAMP

PROJECT #90

PROCEDURES:

1. Check the stock size
2. Cut stock to 6¼" long
3. Layout all dimensions
    a. Center punch the 1" radius
4. Rough cut the 1" radius to the ½" diameter
    a. Use a vertical band saw
5. Mount a rotary table on a vertical mill
    a. Center the table to the center of the spindle
        (1) Mount a center in the spindle
        (2) Bring the spindle down until the center has lined the table to the center
        (3) Clamp the table to the milling table
6. A dial indicator may be used to center the rotary table
    a. Mount the stock on the rotary table
        (1) Mount on a thin piece of stock or parallels to protect the table
        (2) Use the center in the spindle to line the center of the 1" radius (the center punch mark)
        (3) Be sure the sides of the stock is square
            (a) Zero the micrometer collars (table and cross) so the center may be re-located
            (b) Use a dial indicator
            (c) Turn the rotary table
7. Return to the center of the 1" radius
    a. Compensate for backlash
    b. Insert a 5/8" end mill

8. Move to the edge
    a. 1" plus ½" the diameter of the end mill 1.3125"
9. Cut the radius to the ½" diameter layout line
    a. Allow 1/16" for turning
10. Cut the other side
    a. Second 1" radius
11. Mill both ends to length
12. Mill the slot
    a. Use a 3/4" end mill
13. Swing the head
14. Cut the angle
    a. Use a fly cutter or shell end mill
15. Remove from the mill
16. Chuck in a lathe to turn the ½" diameter
    a. Use a four-jaw chuck
    b. True the stock
18. Turn the ½" diameter
19. De-bur
20. Case harden

MACHINE SHOP

PROJECT #91

GOOSE NECK CLAMP

710

GOOSE NECK CLAMP

PROJECT #91

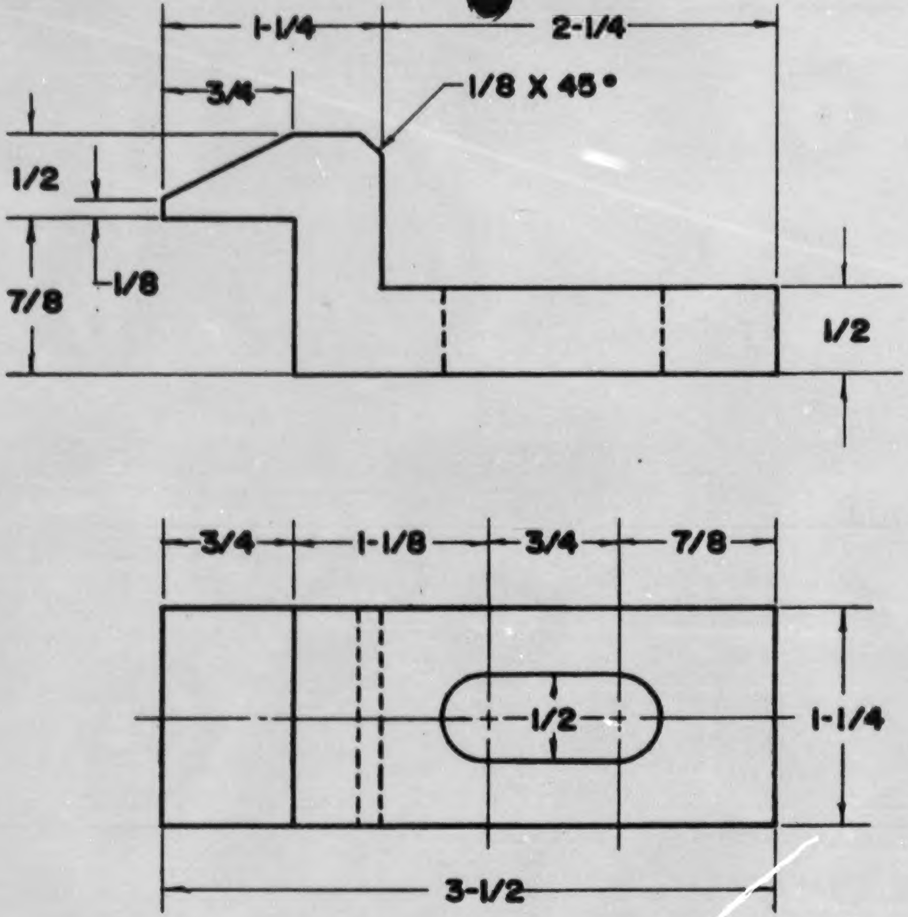
COURSES: Milling Machines, Grinders

MATERIALS: Two Each - Cold Rolled Steel Flat 1¼" x 1 7/8" x 3 3/4" long

TASK:

ML - 1	Alining a vise on a milling machine
ML - 6	Fly cutter/shell end mill (face milling
ML - 7	Angle milling on a vertical milling machine
ML - 2	Slot milling on a vertical milling machine
ML - 5	End milling
G - 1	Dressing the wheel for grinding
G - 13	Grinding on a magnetic chuck
G - 10	Grinding a finishing cut
G - 8	Alining work to be ground
G - 6	Grinding a vertical surface on a surface grinder
G - 7	Form grinding on a surface grinder
G - 4	Grinding a flat on a surface grinder
G - 11	Grinding a universal angle vise
G - 5	Grinding an angle on a surface grinder

711


1-1/4
2-1/4
3/4
1/8 X 45°
1/2
1/8
7/8
1/2
3/4
1-1/8
3/4
7/8
1/2
1-1/4
3-1/2

MATERIAL: 2 EA. CRS FLAT 1-1/4 X 1-3/8 X 3-3/4

TOLERANCE: ± 1/64

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB / CKD.			
AP'VD.			

TITLE
GOOSE NECK CLAMP

NO.
71
91

712

BRUNING 40-105

GOOSE NECK CLAMP

PROJECT #91

SPECIAL INSTRUCTIONS: Part of this project may be rough cut on a vertical saw to conserve time. Grind all over (optional).

PROCEDURES:

1. Check the stock size
2. Cut to 3 3/4" long
3. Layout the stock
4. True a vise on a vertical mill
5. Mount the stock in the vise on parallels
6. Insert a shell end mill
7. Mill the long surface on above the slot location
8. Swing the head 45°
9. Cut the 45° x 1/8" angle
10. Swing the head and mill the long angle
11. Mill the slot
    - a. Use an end mill
12. Turn the stock over
    - a. Place on parallels
    - b. Have the short surface extending from the edge of the vice jaws
13. Mill the short surface
    - a. Use an end mill
14. Cut to length
15. Case harden (optional)
16. Mount on a surface grinder
    - a. Dress the wheel
    - b. Use a magnetic chuck

714

        (1) Align the work

    c. Finish grind all surfaces

17. Grind the vertical surface

    a. Form grind the 90° angle

18. Grind the long flat surface

19. Turn on the magnetic chuck and grind the sides

20. Mount in a universal angle vise

21. Grind the angles

22. Grind the flat on the top surface

23. Grind the ends vertically

24. Turn the piece

25. Grind the bottom

26. Grind the vertical surface to the short flat

    a. Form grind the 90° angle

27. Grind the short flat

28. Hone all sharp edges

    a. Use a hand honing stone

MACHINE SHOP

PROJECT #92

3" T-SLOT BOLT

716

3" T-SLOT BOLT

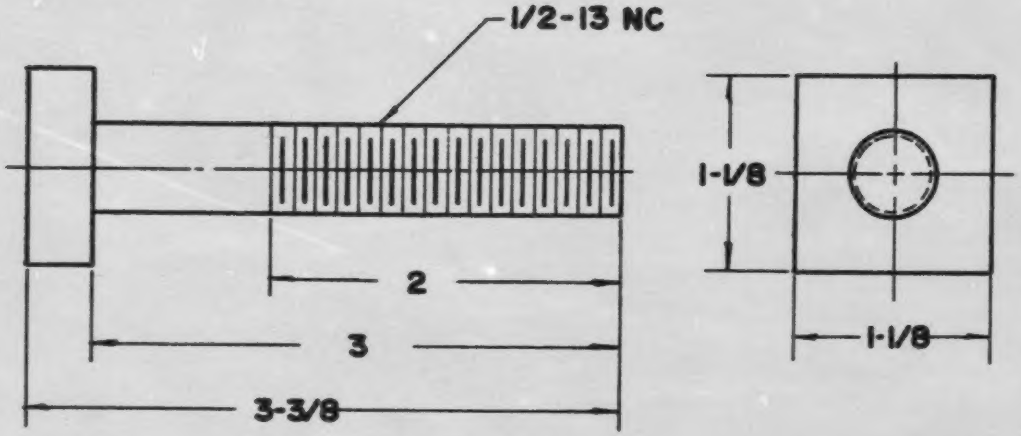
PROJECT #92

COURSES: Lathe, Milling Machines

MATERIALS: One Each - Hot Rolled Steel Round 1 5/8" diameter x 4½" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 10	Center drilling in a lathe
L - 8	Facing in a lathe
L - 9	Turning in a lathe
L - 14	Turning a shoulder on a lathe
L - 22	Cutting external V-threads in a lathe
ML - 12	Straddle milling
ML - 14	Indexing on a milling machine


1/2-13 NC
2
3
3-3/8
1-1/8
1-1/8

MATERIAL: 1 EA. HRS ROUND 1-5/8 DIA. X 4-1/2

TOLERANCE: +-1/64

718

SCALE FULL		REVISIONS	BY	DATE
DATE				
DR'N GWB	CKD.			
AP'VD.				
TITLE 3" T-SLOT BOLT			NO. 718	

3" T-SLOT BOLT

PROJECT #92

PROCEDURES:

1. Check the stock size
2. Cut to 4" long
3. Chuck in a lathe
    a. Use a three- jaw chuck
    b. Chuck on 3/4"
4. Center drill
5. Insert tailstock center
    a. Face
6. Turn to 1.600" 3½" long
7. Turn the ½" diameter to the shoulder
    a. Face the shoulder
8. Cut the threads
9. Cut 3½" long
    a. Use a horizontal band saw
10. Chuck in a lathe on the threads
11. Face to length
12. Mount in a horizontal mill
    a. In a dividing head
        (1) Have the head vertical
13. Mount two side milling cutters on the arbor
    a. Space 1 1/8" apart
14. Center the head of the bolt in the center of the cutters
15. Straddle mill two sides
16. Index ¼ of a turn

17. Straddle mill the final two sides

18. De-bur

19. Clean the threads with a thread file or a die

MACHINE SHOP

PROJECT #93

1-2-3 BLOCKS II

722

1-2-3 BLOCKS II

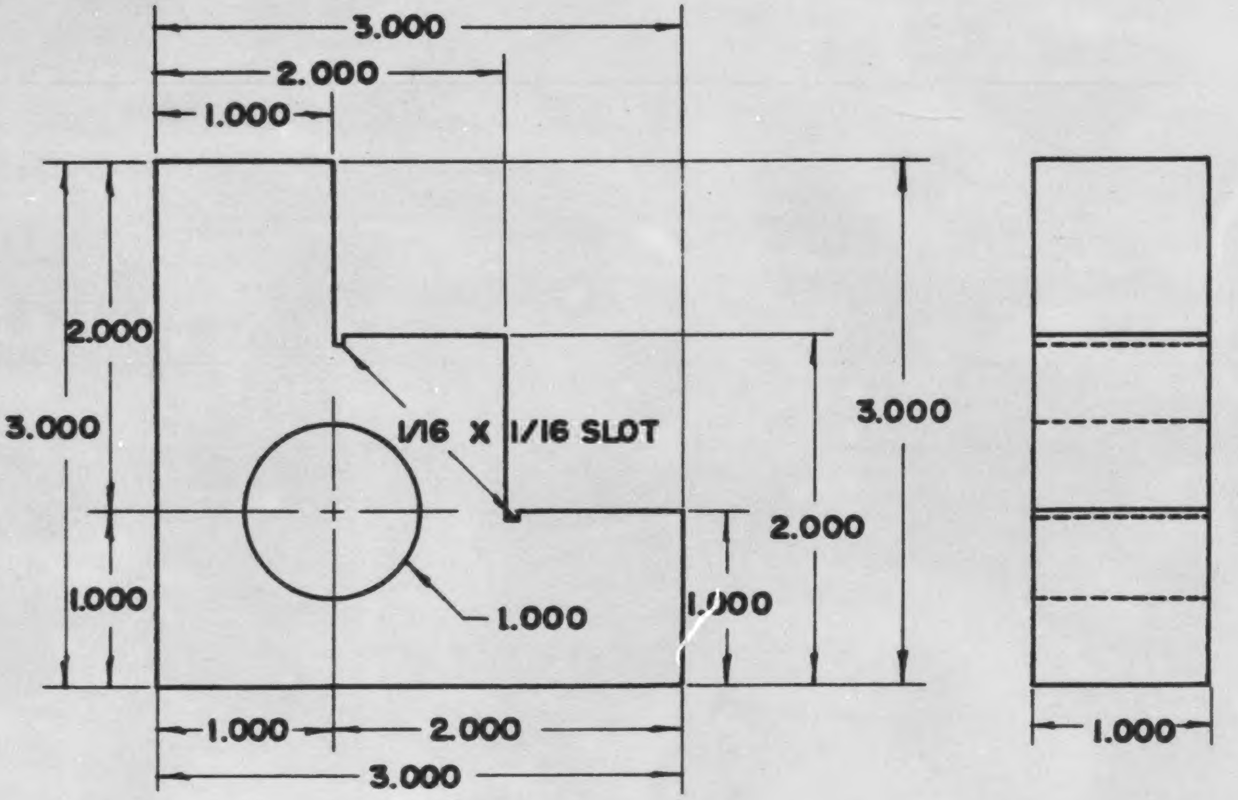
PROJECT #93

COURSES: Milling Machines, Grinders

MATERIALS: Two Each - 1045 SAE Carbon Steel Flat 1" x 3" x 3¼" long

TASK:	ML - 1	Aligning a vise on a milling machine
	ML - 4	Plain milling/slab milling
	ML - 3	Slot milling on a horizontal milling machine
	ML - 13	Slitting and parting
	G - 13	Grinding on a magnetic chuck
	G - 4	Grinding a flat on a surface grinder
	G - 1	Dressing the wheel for grinding
	G - 6	Grinding a vertical surface on a surface grinder
	G - 7	Form grinding on a surface grinder
	G - 15	Using a cut-off wheel

723


3.000
2.000
1.000
2.000
3.000
1/16 X 1/16 SLOT
3.000
2.000
1.000
1.000
1.000
1.000
1.000
2.000
3.000
1.000

MATERIAL: 2 EA. 1045 SAE CARBON STEEL 1 X 3 X 3-1/4   **TOLERANCES:** +- 1/64 · +- .002

724

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB · CKD.			
AP'VD.			

TITLE 1-2-3 BLOCKS II

NO. 725

93

BRUNING 40-105

1-2-3 BLOCKS II

PROJECT #93

SPECIAL INSTRUCTIONS: Allow .010" for grinding

PROCEDURES:

1. Check the stock size
2. Cut to 3¼" long
3. Align a vise on a horizontal mill
4. Mill the ends square
   - a. Use a plain mill
5. Mill the steps
   - a. Use a side mill
6. Mill the slots
   - a. Use a slitting saw
7. Place on a drill press
   - a. Drill the hole
   - b. Ream the hole
8. Heat treat
9. Grind on a surface grinder
   - a. Use a magnetic chuck
10. Grind the sides
    - a. The surface at right angles to the hole
11. Mount in a vise
    - a. True the vise
12. Dress the wheel
13. Grind the 3' long flat surfaces square with each other
14. Turn the block
    - a. Mount on parallels

726

  b. Have the bottom step extending from the vise

15. Grind the top

16. Grind all vertical and horizontal steps to form the 90° angles

17. Grind the slot with a 1/16" cut-off wheel

18. Hone all edges to remove the burs

  a. Use a hand hone

MACHINE SHOP

PROJECT #94

THREE INCH STEP BLOCKS

728

THREE INCH STEP BLOCKS

PROJECT #94

COURSES: Milling Machine

MATERIALS: Two Each - Cold Rolled Steel Flat 3" x 1" x 3 1/8" long

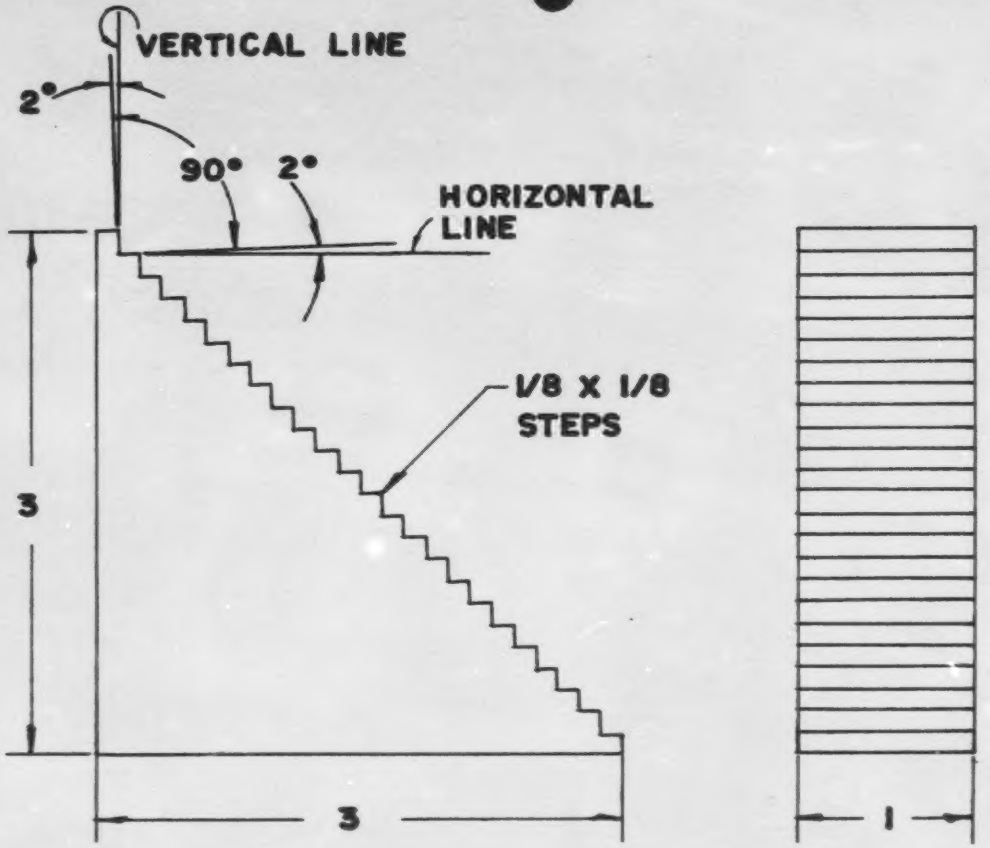
TASK:

ML - 1 Align a vise on a milling machine

ML - 6 Fly cutter/shell end mill (face milling)

ML - 5 End milling

ML - 7 Angle milling on a vertical milling machine


VERTICAL LINE
2°
90°
2°
HORIZONTAL LINE
1/8 X 1/8 STEPS
3
3
1

MATERIAL: 2 EA. CRS FLAT 3 X 1 X 3-1/8

TOLERANCES: +-1/64 · +-1/2°

730

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB · CKD.			
AP'VD.			

TITLE THREE INCH STEP BLOCKS

NO. 731

BRUNING 40-105

THREE INCH STEP BLOCKS

PROJECT #94

PROCEDURES:

1. Check the stock size
2. Cut to 3 1/8" long
3. Align a vise on the table
4. Insert the stock in the vise
    - a. Square in the vise
        - (1) Saw cut side up
5. Mill the saw cut side square
    - a. Both ends
    - b. Use a shell end mill or a fly cutter
6. Layout the 45° angle at the top of the steps
7. Mount in the vise
    - a. Have the layout line parallel to the top of the vise and at least 1/4" above
8. Mill to the line
9. Mount in the vise with the 3" flat on parallels and the 45° layout line extending from the side of the vise jaws
    - a. The second step block may be placed in the opposite end of the vise to keep the jaws parallel
10. Tilt the head 2°
11. Insert an end mill
12. Line the edge of the end mill with the edge of the second 3" side
    - a. Zero the table micrometer collar
13. Touch the top and zero the knee (table elevating handle)
14. Move the table .125" from the edge
15. Cut .125" deep cutting the first angle

16. Repeat this operation until all teeth are cut

17. Debur

733

MACHINE SHOP

PROJECT #95

T-SLOT NUTS

734

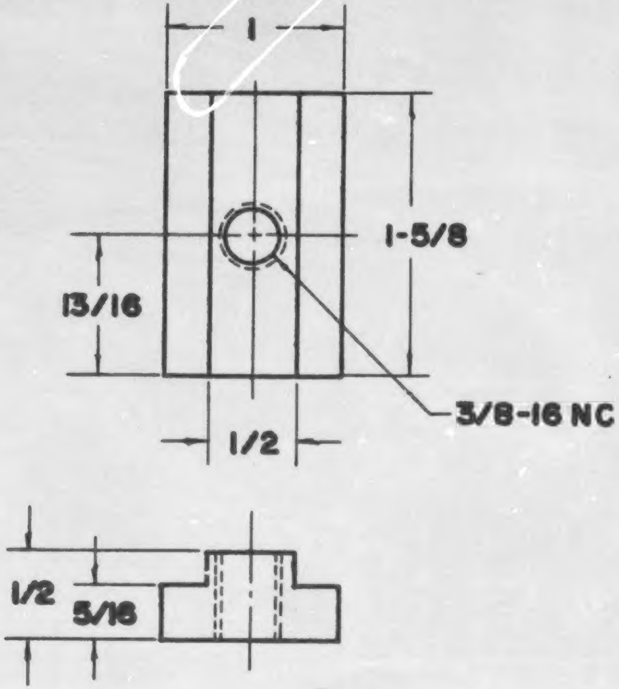
T-SLOT NUTS

PROJECT #95

COURSES: Drill Presses, Milling Machines

MATERIALS: One Each - Cold Rolled Steel Flats ½" x 1" x 6" long

TASK:	ML - 12	Straddle milling
	ML - 13	Slitting and parting
	D - 1	Drilling on a drill press
	D - 7	Tapping on a drill press


1
1-5/8
13/16
3/8-16 NC
1/2
1/2
5/16

MATERIAL: 2 EA. CRS FLAT 1/2 X 1 X 6

TOLERANCE: +-1/64

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB / CKD.			
AP'VD.			

TITLE T-SLOT NUT	NO. 73

736

95

T-SLOT NUTS

PROJECT #95

PROCEDURES:

1. Check the stock size
2. Cut to 6" long
3. Clamp the stock to a horizontal milling table
    a. Place the clamps one on each end
    b. Indicate true
4. Place two side milling cutters 1/2" apart on the arbor
5. Center the cutters over the stock
6. Straddle mill the upright
    a. Mill between the clamps
7. Turn the stock 90° and indicate
    a. Place three parallels under the stock
        (1) Parallels must be placed so the slitting saw will not hit them
    b. Clamp over the parallels
8. Mount a slitting saw on the arbor
9. Use the micrometer collar to cut to length
10. Cut to length
11. Drill and tap the holes
    a. Use a drill press
12. Debur

738

MACHINE SHOP

PROJECT #96

DIE STOCK

739

DIE STOCK

PROJECT #96

COURSES: Measuring, Drill Presses, Lathe, Milling Machines

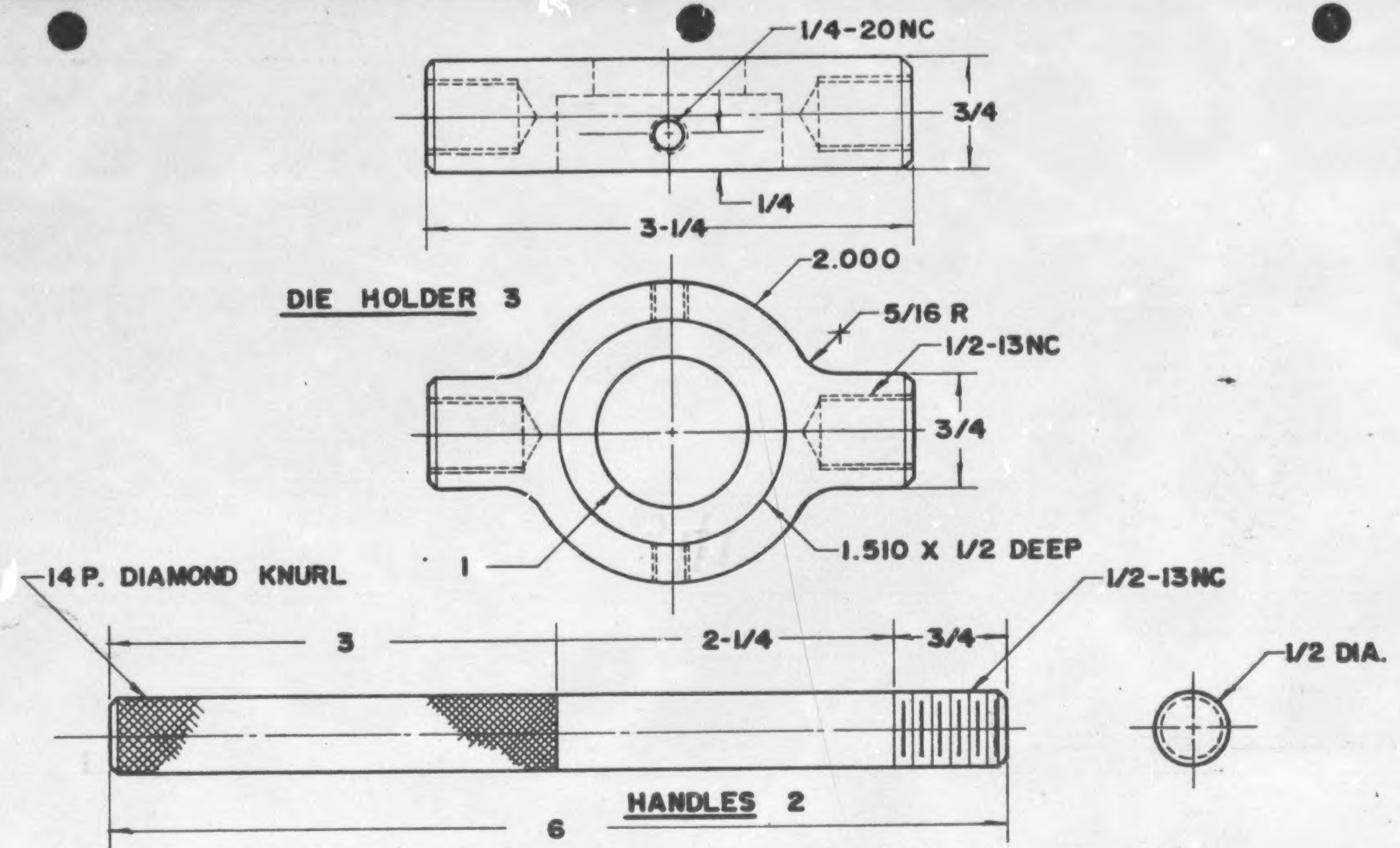
MATERIALS: One Each - Cold Rolled Steel Flat 3/4" x 2" x 3½" long

Two Each - Cold Rolled Steel Round ½" diameter x 6¼" long

Two Each - Allen Head Set Screws ¼ - 20NC x ¼" long

TASK:

L - 37	Chucking in a collet chuck
L - 8	Facing in a lathe
L - 22	Cutting external V-threads in a lathe
L - 10	Center drilling in a lathe
L - 15	Knurling on a lathe
ML - 17	Using a rotary table on a drill press machine
ML - 5	End milling
D - 9	Using a rotary table on a milling machine
D - 8	Center drilling on a drill press
D - 1	Drilling on a drill press
D - 7	Tapping on a drill press
D - 2	Reaming on a drill press
D - 3	Boring on a drill press
M - 37	Measuring with a telescoping gage
M - 30	Measuring with an outside micrometer caliper
L - 32	Boring in a lathe
L - 31	Using a face plate


1/4-20NC
3/4
1/4
3-1/4
2.000
DIE HOLDER 3
5/16 R
1/2-13NC
3/4
1
1.510 X 1/2 DEEP
14 P. DIAMOND KNURL
1/2-13NC
3
2-1/4
3/4
1/2 DIA.
HANDLES 2
6

NOTE: CHAMFER ALL EDGES 1/16 X 45°

TOLERANCES: +- 1/64 · +-.003

741

NO.	REQ.	NAME AND OR SIZE	MAT.
3	1	3/4 X 2 X 3-1/2 FLAT	CRS
2	1	1/2 DIA. X 6-1/4 ROUND	CRS
1	2	1/4-20 NC X 1/4 ALLEN HD. SET SCREWS	

SCALE FULL
DATE
DR'N GWB CKD.
AP'VD.

REVISIONS	BY	DATE

TITLE DIE STOCK
NO. 742

96

BRUNING 40-105

DIE STOCK

PROJECT #96

PROCEDURES: Handles

1. Check the stock size ½" diameter
2. Cut to 6¼" long
3. Chuck in a lathe
    a. Use a collet chuck
4. Face one end
5. Cut the threads
6. Reverse ends
7. Center drill
8. Knurl
9. Chamfer

Die Holder

10. Check the stock size 3/4" x 2"
11. Cut to 3½" long
12. Mount a rotary table on a vertical mill
    a. Center with the spindle
13. Center the stock on the rotary table
14. Mill the 2" outside diameter
    a. Use an end mill
15. Mill the ends to length
16. Leave the stock on the rotary table
17. Mount the rotary table vertically on a drill press
18. Center drill, drill and tap the ½-13 NC holes
    a. Turn the rotary table 90°
19. Center drill, drill and tap the ¼-20 NC holes

20. Lay the rotary table flat

    a. Center with the spindle

        (1) Use a dead center in the center punch of the 2" diameter

21. Drill and ream the 1" hole

22. Bore the 1.510" hole

    a. Check with a telescoping gage and an outside micrometer

Alternate: The die stock may be mounted in a lathe on a face plate. Drill, ream and bore

23. Debur

24. Assemble

744

MACHINE SHOP

PROJECT #97

GEARED ASH TRAY

745

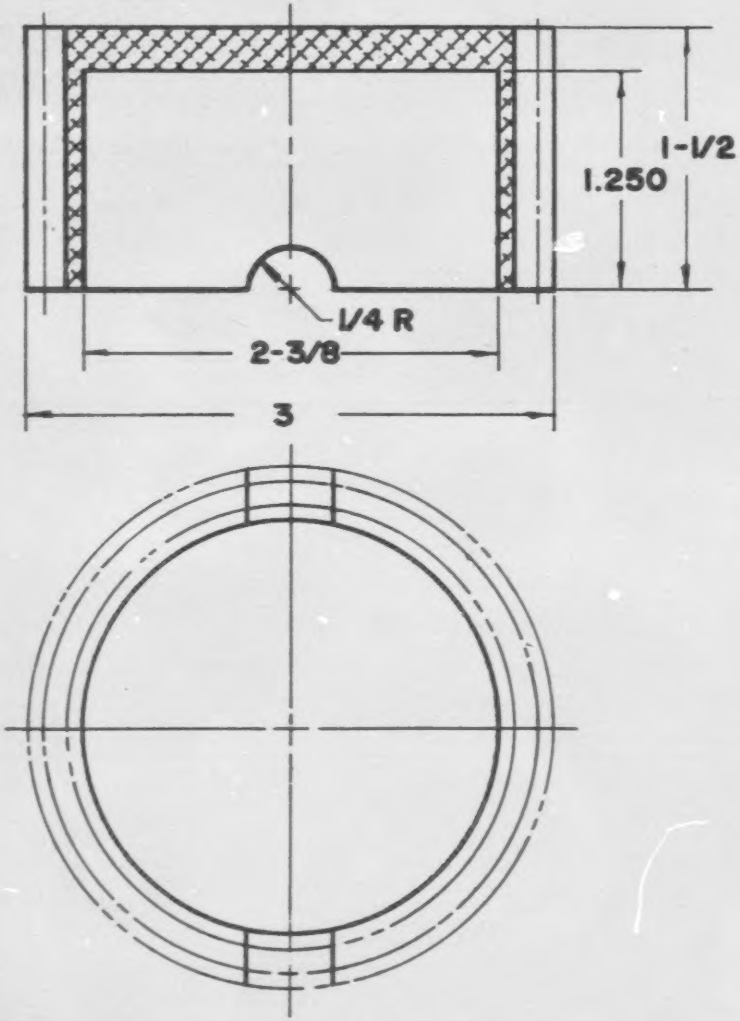
GEARED ASH TRAY

PROJECT #97

COURSES: Measuring, Lathe, Milling Machines

MATERIALS: One Each - Aluminum Round 6061-T6 3" diameter x 4" long

TASK:	L - 6	Chucking in a three-jaw chuck
	L - 8	Facing in a lathe
	L - 10	Center drilling in a lathe
	ML - 11	Form milling
	ML - 15	Gear cutting on a milling machine
	ML - 14	Indexing on a milling machine
	L - 31	Boring in a lathe
	L - 26	Using a micrometer stop
	M - 32	Measuring with an inside micrometer
	M - 33	Measuring with a micrometer depth gage



GEAR DATA

1. PITCH DIA. = 2.8
2. NO. OF TEETH = 28
3. DIAMETRAL PITCH = 10
4. ADDENDUM = .1
5. DEDENDUM = .1157
6. WHOLE DEPTH = .2157
7. CLEARANCE = .0157
8. OUTSIDE DIAMETER = 3.0
9. ROOT DIAMETER = 2.5686
10. BASE CIRCLE = 2.71
11. PRESSURE ANGLE = 14.5°
12. CIRCULAR PITCH = .31416
13. CIRCULAR THICKNESS = .1570796
14. CHORDAL THICKNESS = .1569973
15. CHORDAL ADDENDUM = .0111316

TOLERANCES: +- 1/64 · +- .003

MATERIAL: 1 EA. 3 DIA. X 4 ALUMINUM ROUND 6061-T6

747

	REVISIONS	BY	DATE
SCALE FULL			
DATE			
DR'N. GWB · CKD.			
AP'VD.			

TITLE GEARED ASH TRAY

NO. 748

97

GEARED ASH TRAY

PROJECT #97

PROCEDURES:

1. Check the stock size
2. Cut to 4" long
3. Chuck in a lathe
    a. Use a three-jaw chuck
4. Face
5. Center drill
6. Remove from the lathe
7. Chuck in a dividing head
8. Mount the proper gear cutter on the arbor
9. Center the cutter using the foot stock
    a. Be sure the head stock and foot stock are in alignment
        (1) Use tongues
10. Mount the foot stock in the center drilled hole
11. Zero for the depth of cut
12. Raise the table for depth
13. Form cut the gear tooth
    a. Be careful not to hit the head stock with the cutter
14. Index and cut the second tooth
15. Continue until all teeth are cut
16. Turn the dividing head vertically
17. Mount a ¼" radius cutter on the arbor
    a. Center it with the center drilled hole
18. Form cut the groove
19. Remove from the mill
20. Cut 1 5/8" long

21. Face to length in a lathe

22. Reverse ends and bore
    a. Check with an inside micrometer
    b. Use a micrometer stop
    c. Use a micrometer depth gage

23. Chamfer all edges

24. Polish in a lathe

750

MACHINE SHOP

PROJECT #98

WENCH

751

WENCH

PROJECT #98

COURSES: Measuring, Bench Work, Layout, Drill Presses, Lathe, Milling Machines, Saws

MATERIALS: One Each - Cold Rolled Steel Round 5" diameter x 2" long

One Each - Cold Rolled Steel Round 1" diameter x 10" long

One Each - Cold Rolled Steel Round ½" diameter x 3½" long

One Each - Hot Rolled Steel Round 1½" diameter x 1" long

One Each - Hot Rolled Steel Flat ¼" x 1½" x 14" long

One Each - Black pipe ½" ID x 4 1/8" long

One Each - Cold Rolled Steel Square 1" x 1" x 5¼" long

One Each - Cold Rolled Steel Square 7/8" x 7/8" x 1¼" long

Two Each - Hot Rolled Steel Flat ¼" x 5½" x 6½" long

One Each - Hot Rolled Steel Flat ¼" x 3½" x 6½" long

Two Each - 3/16" x 1½" Roll Pin

One Each - 3/4" Flat Washer

One Each - 5/8" Flat Washer

One Each - Compression Spring 3/8" ID x 1" long x 1/32" Coil

Two Each - 10 - 32 NF x 3/8" long Allen Head Set Screws

Four Each - 10 - 32 NF x ¼" long Allen Head Set Screws

One Each - Key Stock 3/16" x 1" long

One Each - Key Stock 1/8" x 1" long

TASK: L/O - 6 Using a divider

D - 1 Drilling on a drill press

D - 2 Reaming on a drill press

D - 7	Tapping on a drill press
B - 10	Using an arbor press
B - 11	Using a broach
S - 6	Cutting a radius on a vertical band saw
B - 6	Using a file
S - 1	Cutting to length on a horizontal band or power hacksaw
L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 17	Filing in a lathe
L - 7	Chucking in a four-jaw chuck
L - 10	Center drilling in a lathe
L - 11	Drilling in a lathe
L - 33	Using a steady rest on a lathe
L - 14	Turning a shoulder on a lathe
L/0 - 9	Using a center punch
ML - 1	Aligning a vise on a milling machine
M - 41	Using a dial indicator
L/0 - 11	Using parallels
ML - 4	Plain milling/slab milling
ML - 10	Key seat milling on a horizontal milling machine
ML - 5	End milling
L - 9	Turning in a lathe
L - 35	Necking in a lathe
L - 22	Cutting external V-threads in a lathe
L - 15	Knurling on a lathe
ML - 8	Angle milling on a horizontal milling machine
L - 12	Reaming in a lathe
ML - 11	Form milling

ML - 15	Gear cutting on a milling machine
ML - 14	Indexing on a milling machine

NO.	REQ.	NAME AND OR SIZE	MAT.
18	1	1/4 X 1-1/2 X 14 FLAT	HRS
17	1	1/8 X 1 KEY STOCK	
16	1	3/16 X 1 KEY STOCK	
15	4	10-32 NF X 3/8 ALLEN HD. SET SCREWS	
14	2	10-32 NF X 1/4 ALLEN HD. SET SCREWS	
13	1	SPRING COMPRESSION 3/8 I.D. X 1 (1/32 COIL)	
12	2	5/8 FLAT WASHER	
11	1	3/4 FLAT WASHER	
10	2	3/16 X 1-1/2 ROLL PIN	
9	1	1/4 X 3-1/2 X 6-1/2 FLAT	HRS
8	2	1/4 X 5-1/2 X 6-1/2 FLAT	HRS
7	1	7/8 X 7/8 X 1-1/4 SQUARE	CRS
6	1	1 X 1 X 5-1/4 SQUARE	CRS
5	1	1/2 I. D. X 4-1/8 BLACK PIPE	
4	1	1/2 DIA. X 3-1/2 ROUND	CRS
3	1	1-1/2 DIA. X 1 ROUND	HRS
2A	1	3/4 PIN (TO BE CUT FROM 1/2 OF ITEM 2)	
2	1	1 DIA. X 10 ROUND (5/8 PIN)	CRS
1A	1	SPOOL PLATE (TO BE CUT FROM 1/2 OF ITEM 1)	
1	1	5 DIA. X 2 ROUND	CRS

755

TOLERANCES: +-1/64 · +-.002 · +-1°

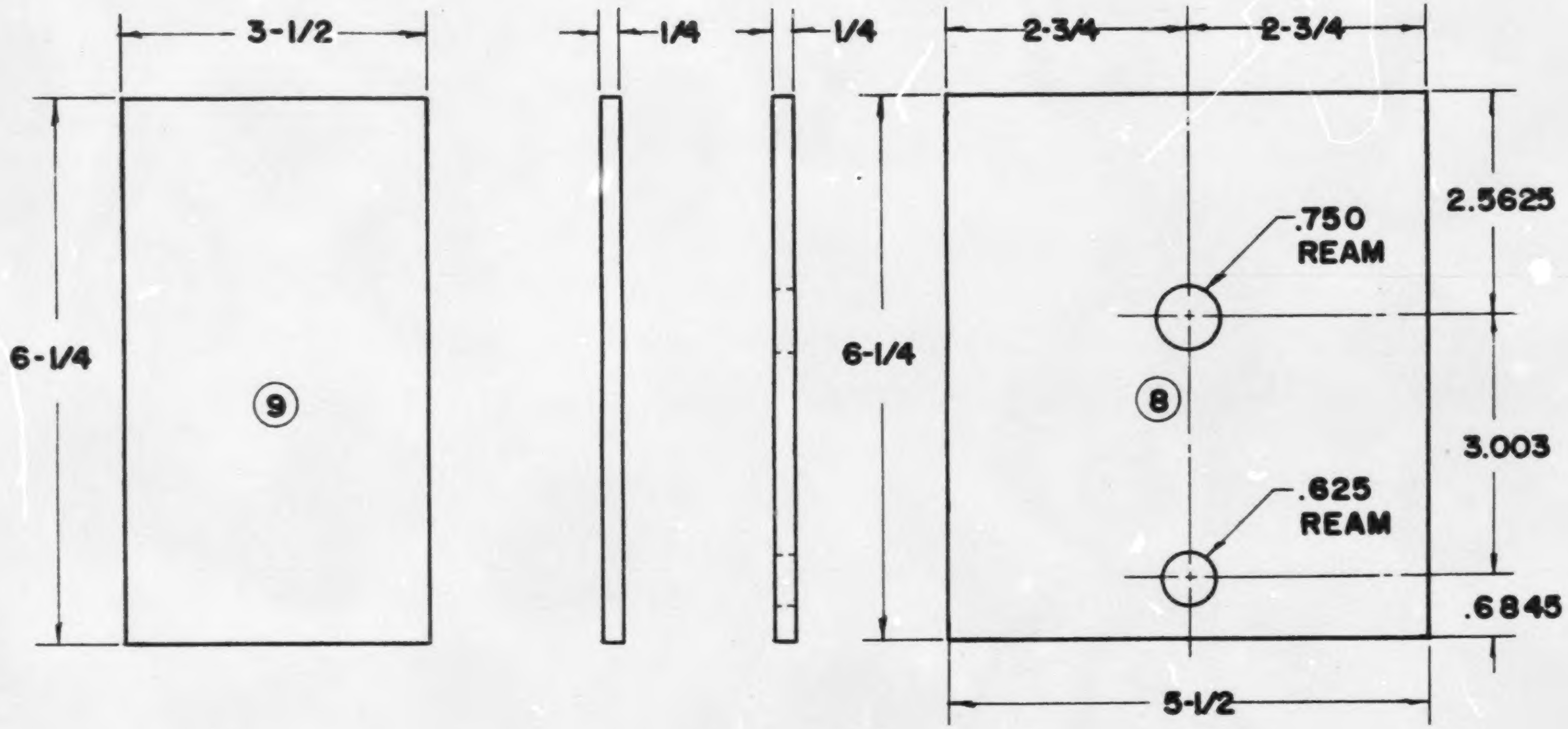
SCALE	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD			
AP'VD			

TITLE
MATERIALS LIST — WINCH

NO
1 OF 7 656

98

BRUNING 40-105


3-1/2
1/4
1/4
2-3/4
2-3/4
6-1/4
9
6-1/4
2.5625
.750
REAM
8
3.003
.625
REAM
.6845
5-1/2

SCALE 1/2 SIZE	REVISIONS	BY	DATE
DATE			
DR'N GWB CKD			
AP'VD			

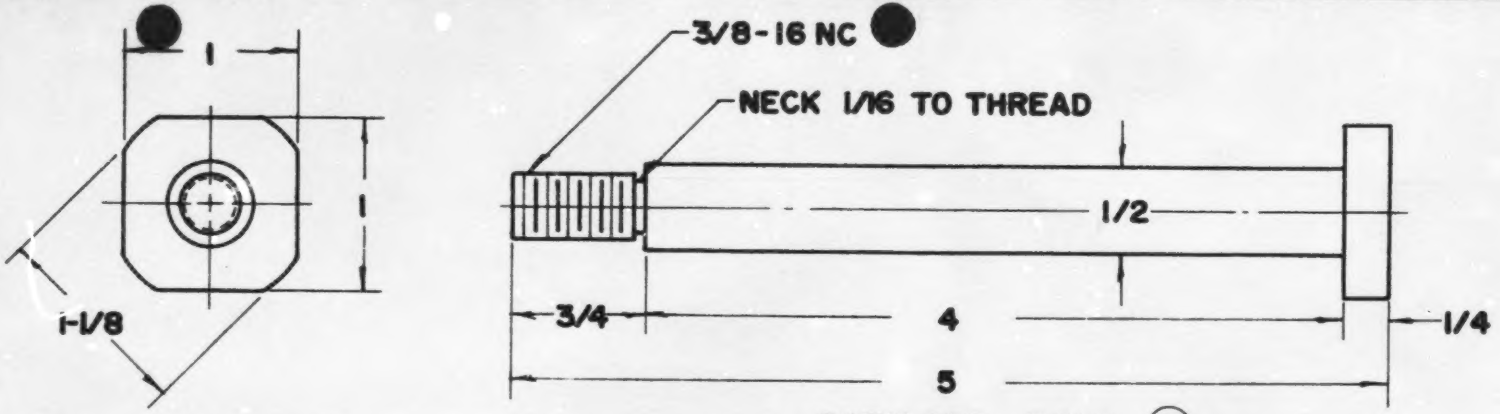
TITLE WINCH- SIDE PLATES AND BASE

NO. 2 OF 98

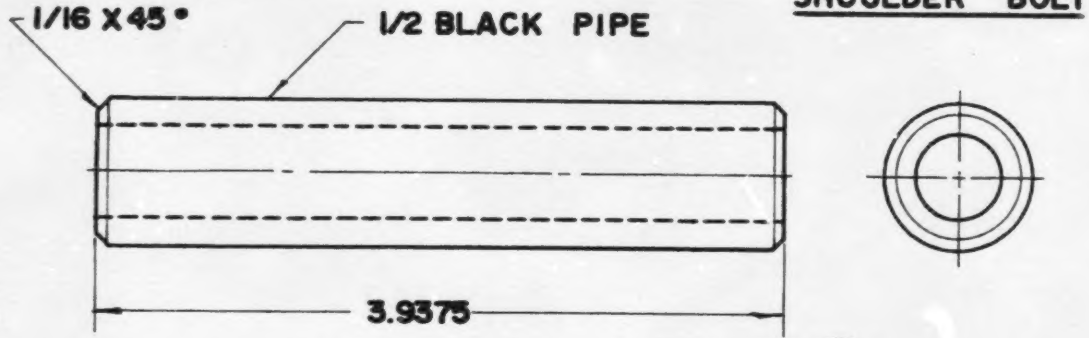
75

757

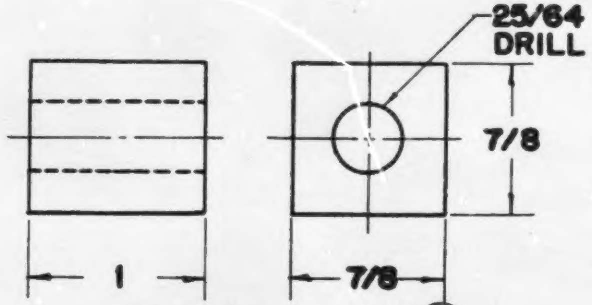
BRUNING 40-105


1
1
1-1/8
3/8-16 NC
NECK 1/16 TO THREAD
1/2
3/4
4
1/4
5

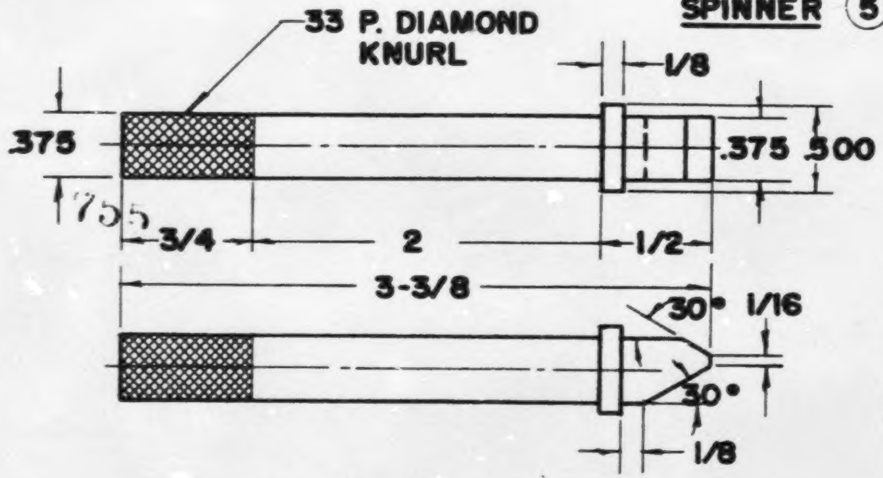
SHOULDER BOLT ⑥


1/16 X 45°
1/2 BLACK PIPE
3.9375

SPINNER ⑤


25/64
DRILL
7/8
1
7/8

RATCHET BODY ⑦


33 P. DIAMOND
KNURL
1/8
.375
755
.375
.500
3/4
2
1/2
3-3/8
30°
1/16
30°
1/8

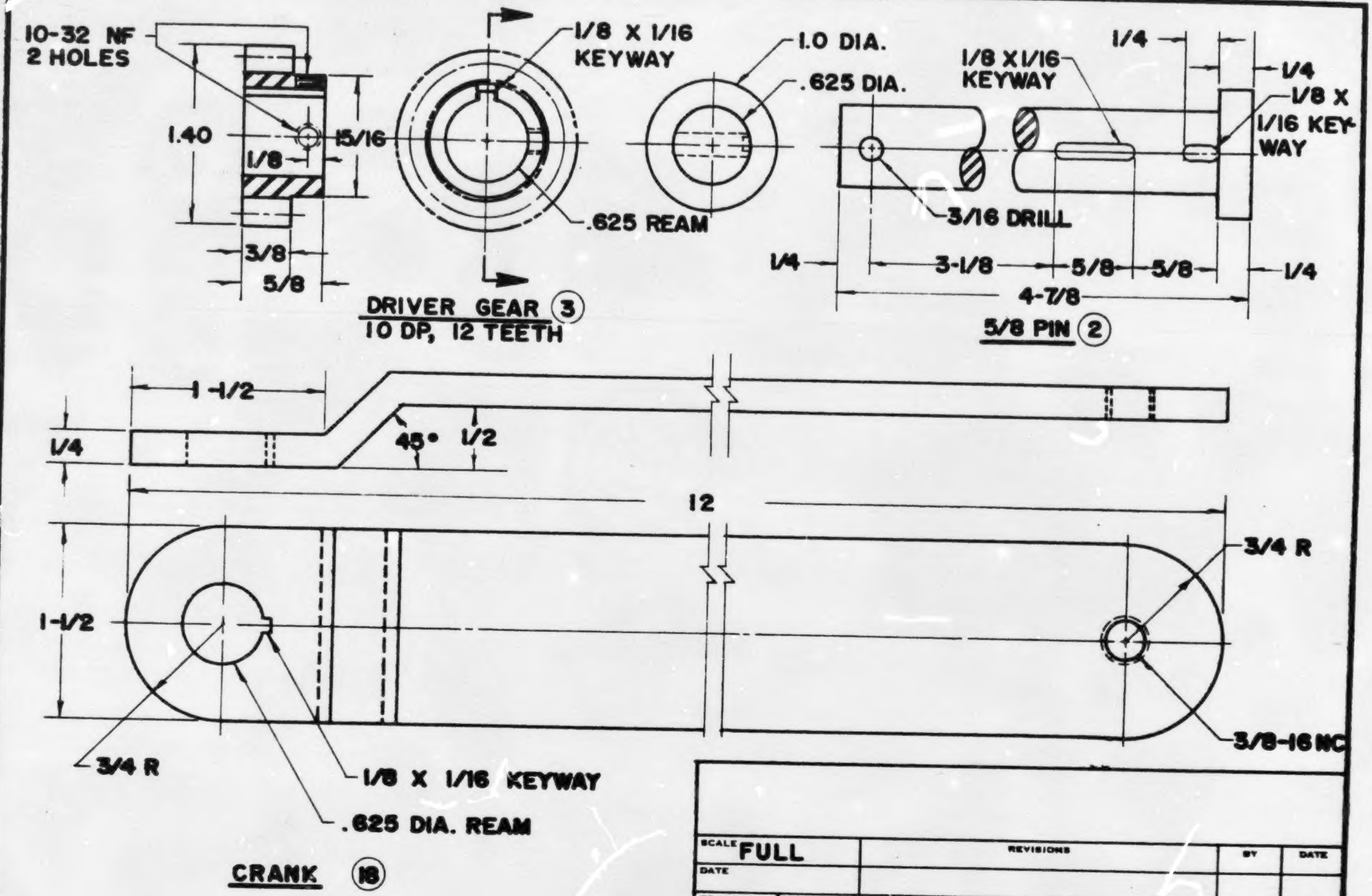
759

RATCHET PIN ④

SCALE FULL
REVISIONS
BY
DATE
DATE
DR'N GWB
CKD.
AP'VD.

TITLE
WINCH PARTS 4,5,6, AND 7

NO. 760
3 OF 6
98


10-32 NF
2 HOLES
1.40
1/8
15/16
3/8
5/8
1/8 X 1/16
KEYWAY
.625 REAM
1.0 DIA.
.625 DIA.
DRIVER GEAR ③
10 DP, 12 TEETH
1/8 X1/16
KEYWAY
1/4
1/4
1/8 X
1/16 KEY-
WAY
3/16 DRILL
1/4
3-1/8
5/8
5/8
1/4
4-7/8
5/8 PIN ②
1-1/2
1/4
45°
1/2
12
1-1/2
3/4 R
3/8-16 NC
3/4 R
1/8 X 1/16 KEYWAY
.625 DIA. REAM
CRANK ⑱

SCALE FULL

DATE

DR'N GWB

CKD.

AP'VD.

REVISIONS	BY	DATE

TITLE

WINCH PARTS 2, 3, AND 18

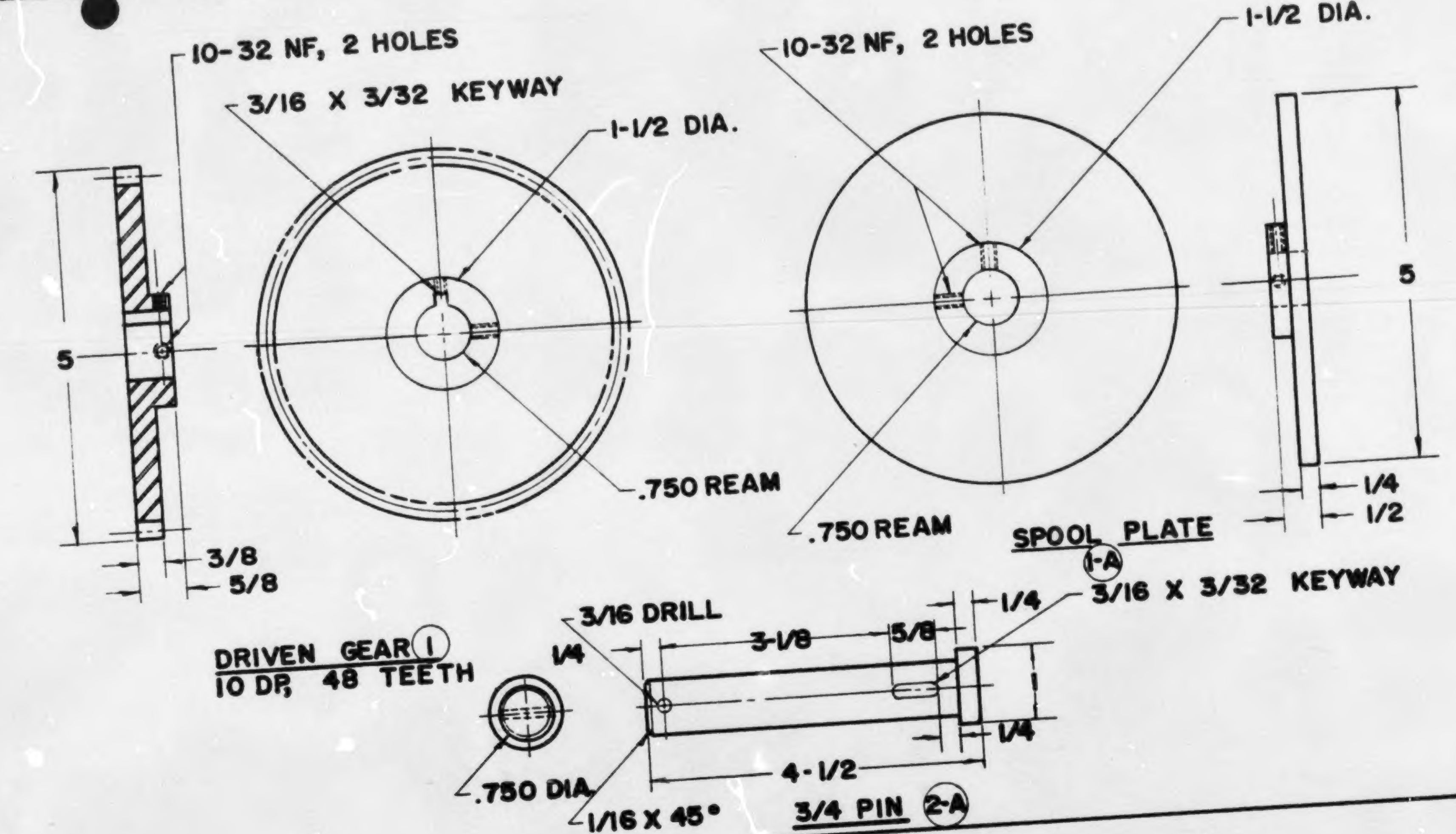
NO.

4 OF 98

761

762

BRUNING 40-105


10-32 NF, 2 HOLES
3/16 X 3/32 KEYWAY
1-1/2 DIA.
5
.750 REAM
3/8
5/8
DRIVEN GEAR ①
10 DP, 48 TEETH
10-32 NF, 2 HOLES
1-1/2 DIA.
5
.750 REAM
1/4
1/2
SPOOL PLATE
1-A
3/16 X 3/32 KEYWAY
1/4
3/16 DRILL
3-1/8
5/8
1/4
1
1/4
.750 DIA.
4-1/2
1/16 X 45°
3/4 PIN
2-A

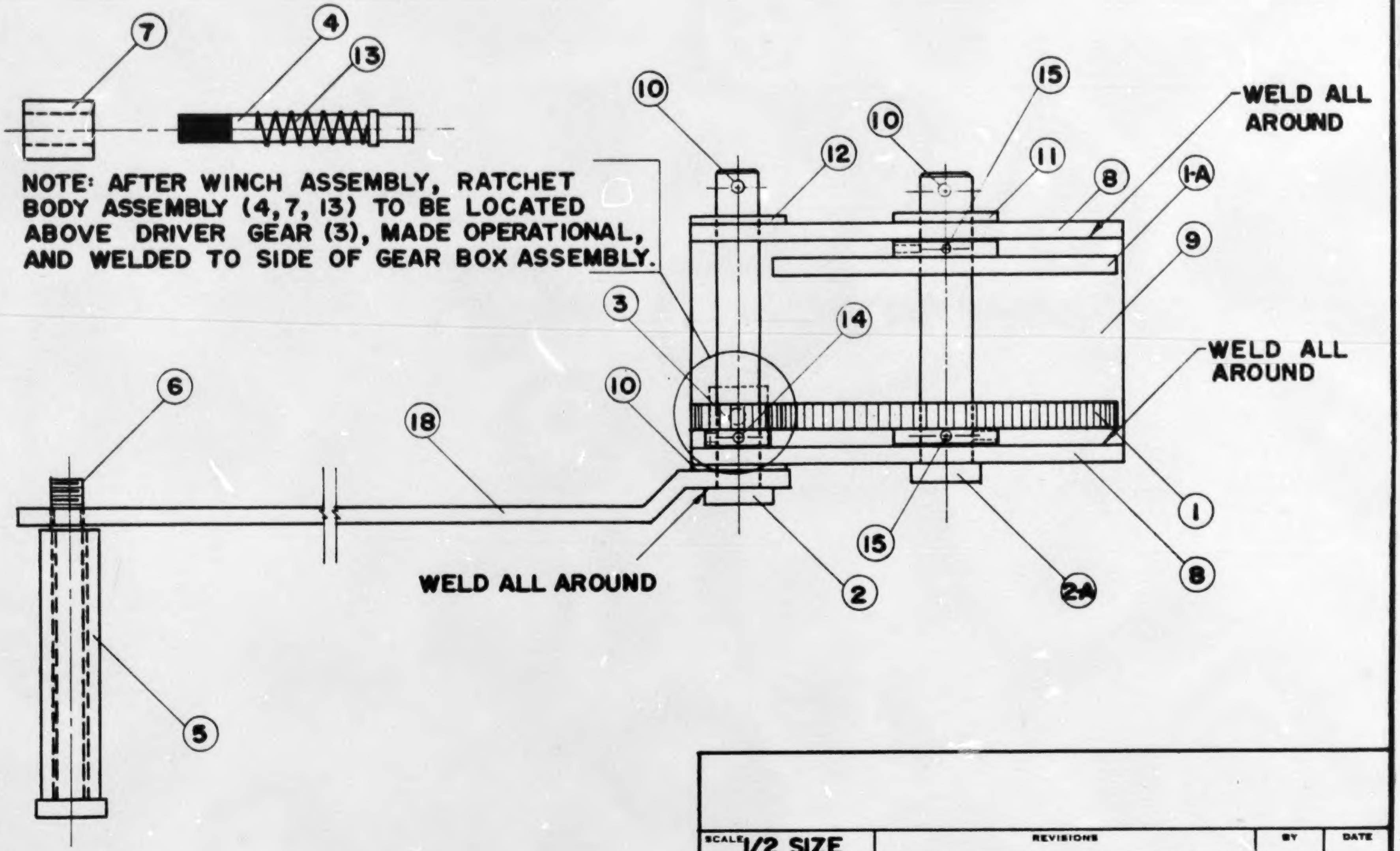
	REVISIONS	BY	DATE
SCALE 1/2 SIZE			
DATE			
DR'N GWB CKD.			
AP'VD.			

TITLE WINCH - PARTS 1, 1-A, AND 2-A

NO. 5 OF 8 764 98

763

BRUNING 40-105


7
4
13
10
10
15
12
11
8
1-A
WELD ALL AROUND
9
3
14
WELD ALL AROUND
6
10
18
1
15
8
WELD ALL AROUND
2
2A
5

NOTE: AFTER WINCH ASSEMBLY, RATCHET BODY ASSEMBLY (4, 7, 13) TO BE LOCATED ABOVE DRIVER GEAR (3), MADE OPERATIONAL, AND WELDED TO SIDE OF GEAR BOX ASSEMBLY.

SCALE 1/2 SIZE	REVISIONS	BY	DATE
DATE			
GWB CKD.			
AP'VD.			

TITLE
WINCH ASSEMBLY

766

NO.
6 O[illegible] 98

BRUNING 40-105

765

WENCH

PROJECT #98

PROCEDURES: Crank

1. Check the stock size ¼" x 1½" flat
2. Cut to length 14" long
3. Heat and bend
4. Layout the holes and radii
    a. Use dividers
5. Drill and ream the 5/8" diameter hole
    a. Use a drill press
6. Drill and tap the 3/8-16 NC hole
7. Broach the keyway
    a. Use a keyway broach
    b. Use an arbor press
8. Cut to length and rough out the radii
    a. Use a vertical band saw
9. File the radii smooth
10. Deburr

Spinner

11. Cut the ½" black pipe 4 1/8" long
    a. Use a horizontal bandsaw
12. Face both ends in a lathe
    a. Use a three-jaw chuck
    b. Face to length
13. Chamfer both ends
    a. Use a file

Ratchet Body

14. Cut the 7/8" square 1¼" long

15. Chuck in a lathe

    a. Use a four-jaw chuck

16. Face both ends

    a. Face to length

17. Center drill the second end

18. Drill 25/64" through

19. Chamfer all edges

3/4" Pin

20. Cut the 1" diameter cold rolled round 4 3/4" long

21. Chuck in a lathe

    a. Use a three-jaw chuck

    b. Chuck on ¼"

22. Face and center drill

    a. Use a steady rest

23. Insert a tailstock center

24. Turn the small diameter and face the shoulder

25. Reverse ends and face to length

26. Chamfer all edges

27. Layout the hole and keyway

    a. Center punch the hole

28. Drill the 3/16" hole

29. True a vise in a horizontal mill

    a. Use a dial indicator

30. Insert the stock

    a. Use parallels

31. Mount a plain milling cutter on the arbor

    a. 3/16" wide

32. Mill the keyway

33. Debur

5/8" Pin

34. With the remaining 1" diameter cold rolled round follow procedure 21 - 28

35. True a vise on a vertical mill

36. Insert the stock

    a. Use parallels

37. Insert a 1/8" end mill

38. Mill the keyways

39. Debur

Shoulder Bolt

40. Cut the 1" square to 5¼" long

41. Chuck in a lathe

    a. Chuck on 4"

    b. Use a four-jaw chuck

    c. True the stock

42. Face one end
43. Center drill
44. Pull the stock out

    a. Chuck on ¼"

    b. Insert a center

    c. True the stock

45. Turn the ½" diameter

46. Turn the 3/8" diameter

47. Neck

48. Cut the threads

49. Reverse ends

    a. Chuck on 4"

b. True the stock

50. Face to length

51. Turn the 1 1/8" diameter

52. Chamfer all edges

Ratchet Pin

53. Cut the ½" cold rolled steel round to 3½" long

54. Turn the .375" diameters in a lathe

55. Face to length

56. Knurl

57. Mount a dividing head on a horizontal mill

58. Mount an angle milling cutter on the arbor

59. Mill the angles

60. Debur

Spool Plate

61. Cut the 5" diameter cold rolled steel round 2" long

62. Chuck in a lathe

    a. Use a four-jaw chuck

    b. Indicate true

63. Face one end

64. Drill and ream through

65. Turn the 1½" diameter shoulder

66. Cut to length in a saw

67. Chuck in a four-jaw chuck

    a. Chuck on the 1½" diameter shoulder

68. Face to length ½" long

69. Drill and tap

    a. Use a drill press

70. Debur

Big Gear

71. The big gear will be made from the remainder of the 5" diameter stock

72. Chuck in a lathe

    a. Use a three-jaw chuck

73. Face

74. Turn the shoulder

75. Reverse ends

76. Face to length

77. Broach the keyway

    a. Use a keyway broach

    b. Use an arbor press

78. Drill and tap the holes

79. Mount on a lathe arbor (see Project #72)

80. Mount the lathe arbor in a dividing head on a horizontal mill

81. Mount a form gear cutter on the arbor

82. Insert the foot stock in the gear blank assembly

83. Cut the gears

84. Debur

Driver Gear

85. Cut the 1½" diameter cold rolled steel stock 1" long

86. Chuck in a three-jaw chuck in a lathe

87. Face and center drill

88. Drill and ream

89. Turn the shoulder

90. Reverse ends

91. Face to length

92. Broach the keyway

93. Drill and tap the holes

94. Mount a lathe arbor in a four-jaw chuck

    a. Indicate true

95. Mount the gear blank on the lathe arbor

96. Turn the 1.400" diameter

97. Mount the gear blank assembly in a dividing head on a horizontal mill

98. Mill the gear teeth

99. Debur

Gear Box Bottom

100. Cut the ¼" x 6½" hot rolled flat 6½" long

101. True a vise on a vertical mill

102. Mill both ends square and to length

    a. Use an end mill

103. Debur

Gear Box Sides

104. Cut the 1/4" x 5½" hot rolled flat 6½" long

105. True a vise on a vertical milling machine

106. Mill the end square and to length

    a. Use an end mill

    b. Use parallels

107. Drill and ream the two holes

    a. Using the same set up on a vertical mill

    b. Use the micrometer collars

Assembly

Weld the box true and square 3-5/8" outside to outside of the gear box side plates. Mount the key in the end of the 5/8" pin. Mount the handle over the key. Slide the 5/8" pin through one side of the gear box. Key the gear to the shaft. Slide the pin through the second side and mount the flat washer and roll pin. Slide the shoulder bolt through the pipe and secure to the handle. Assemble the big gear and spool plate on 3/4" pin and secure the roll pin. Tighten all set screws and lap the gears if necessary. Mount the ratchet assembly on side of gear box with the ratchet pin in the little gear. Clamp with a C-clamp. Adjust assembly until ratchet assembly works properly. Weld and remove C-clamp.

MACHINE SHOP

PROJECT #99

¼" PITCH, 1" LEAD, LEFT HAND, SQUARE THREAD BOLT

774

¼" PITCH, 1" LEAD, LEFT HAND, SQUARE THREAD BOLT

PROJECT #99

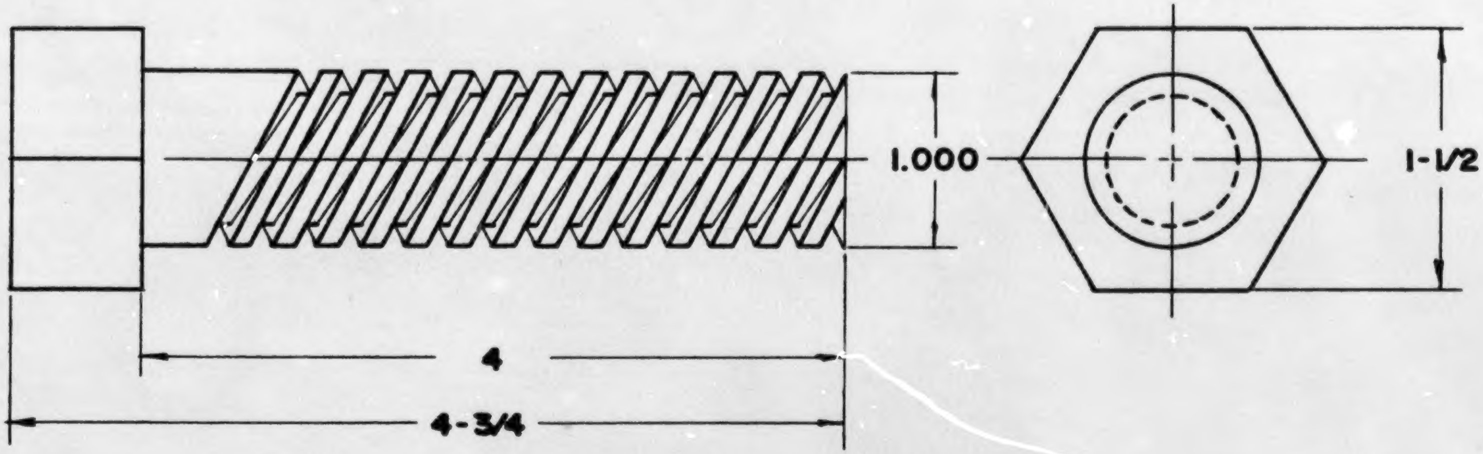
COURSES: Lathe, Milling Machines

MATERIALS: One Each - Aluminum Round 6061-T6 1 3/4" diameter x 6" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 9	Turning in a lathe
L - 14	Turning a shoulder on a lathe
ML - 16	Helical milling on a milling machine
ML - 5	End milling
ML - 14	Indexing on a milling machine
ML - 4	Plain milling/slab milling
ML - 12	Straddle milling

775



NOTE: THE THREAD AND HEX MUST BE CUT ON THE MILLING MACHINE.

MATERIAL: 1 EA. ALUMINUM ROUND 6061 T-6
1-3/4 DIA. X 6

TOLERANCES: +- 1/64 · +- .002

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB / CKD.			
AP'VD.			

TITLE
1/4 PITCH, 1" LEAD, LEFT HAND
SQUARE THREAD, BOLT

NO. 777

99

776

BRUNING 40-105

¼" PITCH, 1" LEAD, LEFT HAND, SQUARE THREAD BOLT

PROJECT #99

SPECIAL INSTRUCTIONS: This project is designed to teach helical milling on a plain milling machine.

PROCEDURES:

1. Check the stock size
2. Cut the stock 6" long
3. Chuck in a lathe
    a. Use a three-jaw chuck
    b. Chuck on 3/4"
4. Face
5. Center drill
6. Turn the 1.732" diameter 5" long
7. Turn the 1.000" diameter 4" long
    a. Face the shoulder
8. Calculate the change gears
    a. An idler gear must be used for left hand threads
9. Set-up a dividing head connected to the change gears mounted to the lead screw
10. Mount stock in the dividing head
    a. Use a foot stock
11. Mount a 1/8" end mill in the spindle
12. Make the first cut
    a. Index
13. Make the second cut and so on
14. Remove the stock from the mill
15. Cut to length

773

    a. Allow 1/8" for squaring

16. Disconnect the change gears
17. Set the dividing head vertically
18. Mount the stock in the dividing head
19. Mount a plain milling cutter
20. Slab mill to length
21. Straddle mill the hex
22. Cut the hex
    a. Index 1/6" of a turn
23. Debur

MACHINE SHOP

PROJECT #100

PARALLELS

780

PARALLELS

PROJECT #100

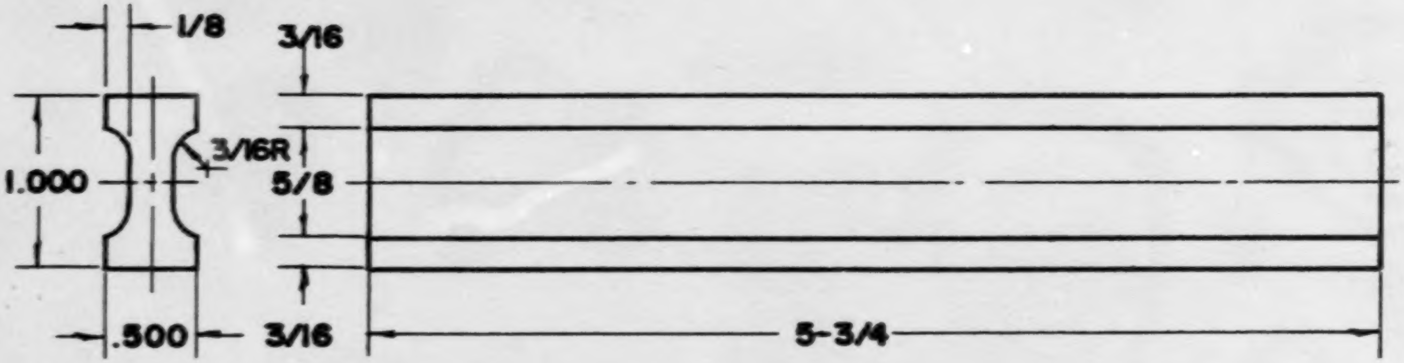
COURSES: Milling Machine, Grinding

MATERIALS: Two Each - Starrett 496 Oil Hardening Steel Flat or Equal
9/16" x 1½" x 5 7/8" long

TASK:

ML - 1	Aligning a vise on a milling machine
ML - 5	End milling
ML - 4	Plain milling/slab milling
ML - 11	Form milling
G - 4	Grinding a flat on a surface grinder
G - 13	Grinding on a magnetic chuck
G - 9	Grinding a roughing cut
G - 10	Grinding a finishing cut
G - 1	Dressing the wheel for grinding
G - 7	Form grinding on a surface grinder

781


1/8
3/16
3/16R
1.000
5/8
.500
3/16
5-3/4

MATERIAL: 2 EA. STARRETT 496 OIL HARDENING STEEL FLAT OR EQUAL 9/16 X 1-1/4 X 5-7/8.

782

TOLERANCES: +-1/64 · +-.0005 · = +-.0005

SCALE FULL
REVISIONS
BY
DATE
DATE
DR. GWB
CKD.
AP'VD.
TITLE
PARALLELS
NO. 783
100

BRUNING 40-105

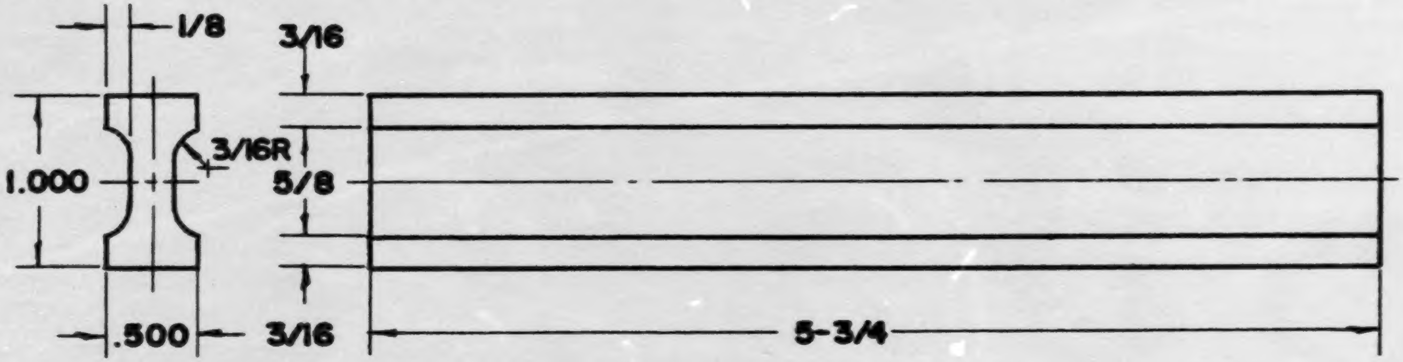
PARALLELS

PROJECT #100

SPECIAL INSTRUCTIONS: Both parallels should be ground together.

PROCEDURES:

1. Check the stock size
2. Layout the part
3. Mill the recess on both sides
    a. True a vice on the mill
    b. Use an end mill or a plain milling cutter
        (1) Rough out the recess
    c. Form mill the radii
4. Heat treat
5. Mount on a surface grinder
    a. Use a magnetic chuck
6. Rough grind all surfaces
7. True and dress the wheel
8. Finish grind all surfaces and radii
9. Hone all edges


1/8
3/16
1.000
3/16R
5/8
.500
3/16
5-3/4

MATERIAL: 2 EA. STARRETT 496 OIL HARDENING STEEL FLAT OR EQUAL 9/16 X 1-1/4 X 5-7/8.

785

TOLERANCES: +-1/64 · +-.0005 · ∠ +-.0005

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N. GWB / CKD.			
AP'VD.			

TITLE **PARALLELS**

NO. 786

100

BRUNING 40-105

PARALLELS

PROJECT #100

SPECIAL INSTRUCTIONS: Both parallels should be ground together.

PROCEDURES:

1. Check the stock size
2. Layout the part
3. Mill the recess on both sides
    - a. True a vice on the mill
    - b. Use an end mill or a plain milling cutter
        - (1) Rough out the recess
    - c. Form mill the radii
4. Heat treat
5. Mount on a surface grinder
    - a. Use a magnetic chuck
6. Rough grind all surfaces
7. True and dress the wheel
8. Finish grind all surfaces and radii
9. Hone all edges

787

MACHINE SHOP

PROJECT #101

TEST BAR

788

TEST BAR

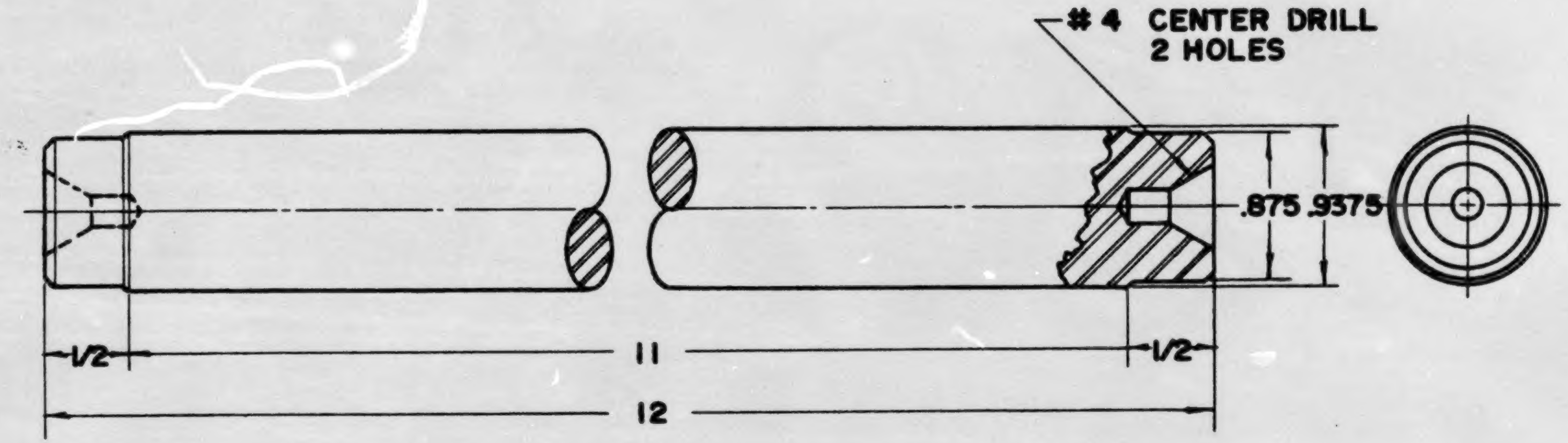
PROJECT #101

COURSES: Measuring, Lathe, Grinding

MATERIALS: One Each - Oil Hardening, Non-Deforming, Tool Steel Round 1" diameter x 12¼" long

TASK:

L - 6	Chucking in a three-jaw chuck
L - 8	Facing in a lathe
L - 10	Center drilling in a lathe
L - 20	Honing in a lathe
M - 41	Using a dial indicator
G - 1	Dressing the wheel for grinding
G - 12	Center the wheel head
G - 9	Grinding a roughing cut
G - 14	Grinding cylindrical work on a tool and cutter grinder
G - 8	Aligning work to be ground
M - 30	Measuring with an outside micrometer caliper
G - 10	Grinding a finishing cut
G - 3	Grinding an angle on a tool and cutter grinder



# 4 CENTER DRILL
2 HOLES
.875
.9375
1/2
11
1/2
12

MATERIAL: I EA. OIL HARDENING NON DEFORMING
TOOL STEEL ROUND I DIA. X 12-1/4

TOLERANCES: +- 1/64 · +- .0005 · = +- .0005

SCALE FULL	REVISIONS	BY	DATE
DATE			
DR'N GWB / CKD.			
AP'VD.			
TITLE TEST BAR	NO. 791		
	101		

790

BRUNING 40-105

TEST BAR

PROJECT #101

PROCEDURES:

1. Check the stock size
2. Cut to 12¼" long
3. Chuck in a lathe
    a. Use a three-jaw chuck
    b. Have 1" extending from the chuck
4. Face one end
5. Center drill
6. Chamfer
7. Reverse ends
8. Face to length
9. Center drill
10. Chamfer
11. Heat treat
12. Return to the lathe and hone/lap center drill holes
13. Mount in a tool and cutter grinder
    a. Dial indicate the table
    b. Mount in a headstock between center
    c. Use a plain wheel
14. Center the wheel head
15. Rough grind the stock
    a. Check both ends to be sure of perfect alignment
        (1) Make necessary corrections

    b. Check with an outside vernier micrometer caliper

16. Grind the under cut .875" diameter

17. Finish grind the .9375" diameter

18. Chamfer

793

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